that were generally a great distance from the areas of suspected hybridization. Perhaps too little is known regarding the genetic variation within each of the species for such broad-based studies to be successful.

A third possible reason for the greater apparent differences between the reference populations in the present study compared to those of previous studies may be the existence of an elevational component of environmental variation in the present study. One interpretation of the greenhouse seedling study would be that genetic differences between the species were not nearly as large as indicated by the analysis of the parent trees, suggesting that elevational differences were relatively large. Although this may in part be true, two potential drawbacks of the seedling study need clarification. First, relatively few seedling traits were measured, so it is quite possible that more diagnostic traits were overlooked. For example, the three most diagnostic traits of mature trees were not examined in the seedlings. Second, it is also possible that juvenile morphological traits in blue and Engelmann spruce do not differ as greatly as mature traits, as the results of the seedling analysis could be interpreted to indicate. For these reasons a great deal of weight cannot be placed on the results of the seedling analysis.

One further note is that the elevational differences within the study area (~ 380 m) were relatively small compared to the elevational range of the combined species in this part of Colorado (~ 1500 m). Associated with this is that the blue spruce reference population was very near its altitudinal limit in this area, while the Engelmann spruce reference population occurred at a fairly low elevation for this species in this area. Again, this suggests that the differences exhibited by the species in this study were probably largely genetic. On this basis a poor separation of species within the area of range overlap in the drainage would suggest possible hybridization between blue and Engelmann spruce. A forthcoming paper will address this possibility.

References

Adams, R. P.: A comparison of multivariate methods for the detection of hybridization. Taxon **31**: 646—661 (1982). — Anderson, E. G.: Introgressive hybridization. 2nd ed. (1968). Hafner Publishing Co., New York and London (1949). — Clifford, H. T. and F. E. Binet: A quantitative study of a presumed hybrid swarm between *Eucalyptus elaeophora* and *E. goniocalyx*. Aust. J. Bot. **2**: 325—336 (1954). — Dancik, B. P. and B. V. Barnes: Multivariate analysis of hybrid populations. Naturaliste Can. **102**: 835—843 (1979). — Daubenmire, R.: Some geographic variation in *Picea sitchensis* and their ecologic interpretation. Can. J. Bot. **46**: 787—798 (1968). — Daubenmire, R.: On the relation between *Picea pungens* and *Picea engelmannii* in the Rocky Mountains. Can. J. Bot. **50**: 733—742 (1972). — Daubenmire, R.: Taxonomic and ecologic relationships between *Picea glauca* and *Picea engelmannii*. Can. J. Bot. **52**: 1545—1560 (1974). — Fisher, R. A.: The use of multiple measurements in taxonomic problems. Ann. Eugenics **7**: 179—188 (1936). — Flake, R. H., L. Urbatsch and B. L. Turner: Chemical documentation of allopatric introgression in *Juniperus*. Syst. Bot. **3**: 129—144 (1978). — Garman, E. H.: The occurrence of spruce in the interior of British Columbia. Can. Dept. Lands and Forest, Tech. Publ. T49. 31 p. (1957). — Gordon, A. O.: The taxonomy and genetics of *Picea rubens* and its relationship to *Picea mariana*. Can. J. Bot. **9**: 781—813 (1976). — Hanover, J. W. and R. C. Wilkinson: A new hybrid between blue spruce and white spruce. Can. J. Bot. **47**: 1693—1700 (1969). — Hanover, J. W., E. Young, W. A. Lemmien and M. van Slooten: Accelerated-Optimal-Growth: A new concept in tree production. Mich. State Univ. Agric. Exper. Sta. Res. Rep. No. 317. 16 p. (1976). — Harlow, W. M. and E. S. Harrar: Textbook of Dendrology. 5th ed. McGraw-Hill, Inc. New York (1969). — Horton, K. W.: Characteristics of subalpine spruce in Alberta. Forestry Branch, Canada Dept. Northern Affairs and National Resources. For. Res. Div. Tech. Note. No. 76. 20 p. (1959). — Jones, J. R. and N. T. Bernard: How to tell Engelmann from blue spruce in the Southwest. USDA For. Serv. Gen. Tech. Rep. RM-34 11 p. (1977). — Klecka, W. R.: Discriminant Analysis, pp. 434—467. In: N. H. Nie, C. H. Hull, J. G. Jenkins, K. Steinbrenner and H. H. Bent (eds.). Statistical Package for the Social Sciences. McGraw-Hill, N. Y. (1976). — Knoke, J. D.: Discriminant Analysis with discrete and continuous variables. Biometrics **38**: 191—200 (1982). — Kudray, G. M. and J. W. Hanover: A preliminary evaluation of the spartan spruce (*Picea glauca* × *P. pungens*). Res. Pap. NO. 405. Mich. State Univ. Agric. Exp. Sta., East Lansing, MI. (1980). — Lachenbruch, P. A. and M. Goldstein: Discriminant Analysis. Biometrics **35**: 69—85 (1979). — Ledig, F. T., R. W. Wilson, J. W. Duffield and G. Maxwell: A discriminant analysis of introgression between *Quercus prinus* L. and *Quercus alba* L. Bull. Torrey Botan. Clubs. **96**: 156—163 (1969). — Mergen, F., D. T. Lester, G. M. Furnival and J. Burley: Discriminant analysis of *Eucalyptus cineria* × *Eucalyptus maculosa* hybrids. Silvae Genet. **15**: 148—154 (1965). — Mitton, J. B. and R. Andalora: Genetic and morphological relationships between blue spruce, *Picea pungens* Engelm. and Engelmann spruce, *Picea engelmannii* Parry in the Colorado Front Range. Can. J. Bot. **59**: 2088—2094 (1981). — Morgenstern, E. K. and J. L. Farrar: Introgressive hybridization in red spruce and black spruce. Univ. of Toronto, Fac. of Forestry Tech. Rept. N0. 4. 46 p. (1964). — Namkoong, G.: Statistical analysis of introgression. Biometrics **22**: 488—502 (1966). — Parker, W. H. and D. G. McLachlan: Morphological variation in white and black spruce: Investigation of natural hybridization between *Picea glauca* and *P. mariana*. Can. J. Bot. **56**: 2512—2520 (1978). — Strong, W. L.: Evidence for *Picea pungens* in north-central Montana and its significance. Can. J. Bot. **56**: 1118—1121 (1978). — Taylor, R. J., S. Williams and R. Daubenmire: Interspecific relationships and the question of introgression between *Picea engelmannii* and *Picea pungens*. Can. J. Bot. **53**: 2547—2555 (1975). — Taylor, T. M. C.: The taxonomic relationship between *Picea glauca* (Moench.) Voss and *P. engelmannii* Parry. Madrono **15**: 111—115 (1959). — Weaver, T. W. III.: Variation in the spruce complex of the northern Rocky Mountains, *Picea glauca, Picea pungens, Picea engelmannii*. Masters thesis, Univ. of Montana (1965). — Wright, J. W.: Species crossability in spruce in relation to distribution and taxonomy. For. Sci. **1**: 319—349 (1955).

Short Note: Increased Growth Rate of Uapaca kirkiana Muell. – Arg. by X-Rays and Gamma Rays

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Summary

The preliminary experiments have revealed significant increased growth rate of *Uapaca kirkiana* seedlings exposed to x-rays and gamma rays. This has given fillip to the application of radiation-induced mutations on the slow growing indigenous, multipurpose fruit trees with possible large scale assistance and cooperation of the International Atomic Energy Agency.

Key words: X-rays, gamma rays, Roentgen, *Uapaca kirkiana*.

Zusammenfassung

In Vorversuchen wurde bei Sämlingen von *Uapaca kirkiana* nach Behandlung mit Röntgen- und Gammastrahlen erhöhtes Wachstum festgestellt. Dies hat dazu angeregt, bei langsamwüchsigen, fruktifizierenden Bäumen dieser, vielen Zwecken dienenden Art, unter Mithilfe der International Atomic Energy Agency, möglichst breit gestreut, strahleninduzierte Mutationen zu erzeugen.

Introduction

In tree breeding, irradiation technology has been used in induction of mutations, improving disease and pest resistance, and isotopic tracer techniques in selection and evaluation of superior plant genotypes.

Although the wild, multipurpose forest fruit trees of Zambia have great potential, yet they have inherent defects of slow growth, low pulp percentage in fruits and susceptibility to pests and pathogens. Here, and for the first time in Zambian forestry, the application of irradiation induced mutation technique has been tried to improve the undesirable traits. This report embraces the early results of growth performance of *Uapaca kirkiana* (local name: musuku).

Materials and Methods

The germinating seeds, young, and old seedlings of *Uapaca kirkiana* were exposed to x-rays using Fedrex equipment with automatic control at the Zambia Airways, Technical Division at Lusaka. The exposure of ten minutes was equivalent to 3 Roentgens. The samples were exposed for 5, 10, 15 and 20 minutes which induced doses of 1.5, 3.0, 4.5 and 6.0 Roentgens respectively. A few germinating seeds were exposed to Radium gamma rays at dosage of 400mR per hour. The materials which were exposed to irradiations is given in *Table 1*. After exposure, the plants were planted near the Research Centre's grounds for close observations.

Tab. 1. — Number of germinating seeds, young and old seedlings exposed to irradiations.

Treatment	Number of germinating seeds	Number of young seedlings (30 days old)	Number of old seedlings (90 days old)
Control	10	10	10
1.5R	5	-	13
3.0R	18	30	15
4.5R	10	10	-
6.0R	10	10	10
Radium gamma rays, 400mR/h	7	-	-

Observations and Results

The plants started showing differential height growth after 4 months. Mean height and standard errors are given in *Table 2*. Germinating seeds were much more responsive to treatments than the young and old seedlings. The treatment 3.0 R proved best of all the treatments, and for germinating seeds it showed 6—7 times higher growth than the control. The dosage 6.0 R seemed to be toxic. Although the experiment was preliminary and unreplicated, yet from the layout of plantings, it was evident that the height differences were due to treatments and not to any soil or other factors.

Acknowledgement

We are grateful to the staff of Zambia Airways for use of their X-ray equipment and to Dr. Chitumbo, Head Isotope Research Unit for guidance and cooperation.

Tab. 2. — Mean height (cm) of 18-month-old plants of *U. kirkiana* after irradiation treatments.

Seedling stage	Treatment						Treatment means	S. error
	Control	1.5R	3.0R	4.5R	6.0R	Radium gamma rays		
Germinating seed	9.6	53.3	62.0	41.5	18.1	59.3	40.63	12.75
Young seedling	20.6	-	35.0	21.2	17.1	-	23.47	6.92
Old seedling	16.1	5.3	17.6	-	5.5	-	11.13	4.87
Over all mean	15.44	29.30	38.20	31.35	13.58	59.30	-	-

Short Note: Über mögliche Kriterien zur Frühselektion auf Trocknis-Resistenz bei Kiefern

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Summary

Two methods were used as possible early selection judgement for drought resistance on some species of the genus *Pinus:* The capacity of recovery of turgescence after artificial withering of leaves and the shoot/root-ratio of dryweight. Significant differences were found between species and provenances respectively. Two seed sources (*P. nigra*, Ankara and *P. sylvestris*, Catacik) were on the first rank in both methods. But otherwise the results are not correlated. They seem to be due to two independent