FIRST TECHNICAL SESSION

Chairman: H. C. Larsson

SOME RELATIONSHIPS OF SEED SOURCE, SEED WEIGHT AND NUMBER OF COTYLEDONS IN RED AND BLACK SPRUCE

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INTRODUCTION

Red spruce, Picea rubens Sarg., and black spruce, P. mariana (Mill.) BSP., are closely related species. An attempt is made here to show (1) differences between these species in seed weight and in cotyledon numbers, (2) how seed weight and cotyledon numbers vary within red spruce and black spruce and (3) relationships of the variables to each other and to the latitude of the seed source.

MATERIAL AND METHODS

The material originated from 15 red spruce seed collections made in Nova Scotia and New Brunswick along with two from West Virginia, and from seven black spruce seed lots from the three Maritime Provinces (fig. 1). The black spruce seeds came from very moist to wet sites and the red spruce from a variety of sites. A randomly chosen sample from each seed lot was hand cleaned. Empty seeds were separated from full seeds by flotation in methyl hydrate. The full seeds were then air dried for three days at room temperature. From three to 10 samples of 100 full seeds from each lot were weighed and the average weight for 1000 full seeds for each seed lot was calculated.

Small samples of each seed lot were sown in the nursery in early May. As soon as most of the seedlings had cast their seed coats, and before the primary shoots had developed, the number of cotyledons on each seedling was recorded for 10 samples of 20 seedlings each (200 seedlings) from most of the seed lots. There were two lots of red spruce and one lot of black spruce each of which consisted of less than 200 but more than 100 seedlings.

RESULTS

When both red spruce and black spruce seed lots were collected on different sites located within the same general area, highly significant differences occurred between the average weights of 1000 full seeds (table 1) and between the average number of cotyledons (table 2) for these species. Even when the average weight of 1000 full seeds of the lightest red spruce seed was compared with that of the heaviest black spruce seed, and when the lowest average number of cotyledons for red spruce was compared to the highest average for black spruce, the chances of the respective averages overlapping were less than one in 100 (tables 3 and 4). Within each species, analysis of variance showed that highly significant differences occurred among the average weights of 100 full seeds and among the average number of cotyledons on seedlings from different seed sources.

[1] Forest Research Laboratory, Canada Department of Forestry and Rural Development, Maritimes Region, Fredericton, N. B. Paper read by D. P. Fowler.

Table 1.--Weights of 1000 full seeds of red spruce and black spruce from different sites in the same general seed-source area.

Seed-source area	Average weight in grams		Difference
	Red spruce	Black spruce	
Northumberland Co., N.B.	2.2806	1.0087	1.2719
Napadogan, N.B.	3.3147	1.2197	2.0950
Acadia Forest Experiment Station, N.B.	3.5658	1.4258	2.1400
Halifax Co., N.S.	3.3083	2.0518	1.2565
Totals:	12.4694	5.7060	6.7634
Averages:	3.1173	1.4265	1.6908

t value = 6.86 (significant at 0.01 level)

Table 2.--Cotyledons on red spruce and black spruce from seeds collected in the same general seed-source area.

Seed-source area	Average number		Difference
	Red spruce	Black spruce	
Northumberland Co., N.B.	5.52	4.58	0.94
Napadogan, N.B.	5.64	4.65	0.99
Acadia Forest Experiment Station, N.B.	6.00	4.86	1.14
Halifax Co., N.S.	6.12	5.09	1.03
Totals:	23.28	19.18	4.10
Averages:	5.82	4.80	1.02

t value = 24.0 (significant at 0.01 level)

Table 3.--Comparison of seed weights: lightest red spruce seed and heaviest black spruce seed.

Species	Seed source	Weight of 1000 full seeds in grams	
		Average	Fiducial limits using t value for 0.01
Red spruce	Northumberland County, N.B.	2.2806	2.2199 - 2.3413
Black spruce	Hants County, N.S.	2.1159	2.0337 - 2.1981

Table 4.--Comparison of cotyledon numbers: red spruce with the smallest average and black spruce with the largest average.

Species	Seed source	Number of cotyledons	
		Average	Fiducial limits using t value for 0.01
Red spruce	Northumberland County, N.B.	5.52	5.37 - 5.67
Black spruce	Halifax County, N.S.	5.09	4.87 - 5.31

Linear regressions were calculated which showed highly significant relationships between the latitude of the seed source (the independent variable) and the average weight of 1000 full seeds (the dependent variable) for both red spruce and black spruce (fig. 2). In red spruce, when the averages for the two seed lots from West Virginia were omitted, this relationship was no longer statistically significant, A linear regression showed a highly significant relationship between the latitude of the seed source (the independent variable) and the average number of cotyledons per seedling (the dependent variable) for red spruce and another showed a significant relationship between these variables in black spruce (fig. 3). A highly significant relationship and a significant relationship were also found between the average weight of 1000 full seeds and the average number of cotyledons in red spruce and black spruce respectively (fig. 4).

DISCUSSION

It should be kept in mind that most of the seed lots used here were from a limited part of the ranges of red spruce and black spruce, the Maritime Provinces, along with two red spruce seed lots from West Virginia which is outside of the range of black spruce. The weights of full seeds in both species varied inversely with latitude. This supports the observation (Woody-Plant Seed Manual, 1948, pp. 16 and 256) that red spruce consists of two races that differ in seed weight and size: the heavier seeds from the Southern Appalachian region and the smaller and lighter seeds from northern collections (P. O. Rudolf, personal correspondence). This should be treated with caution as the full seeds of red spruce from the Acadia Forest Experiment Station were heavier (3.566 gm. per 1000 full seeds) than those in one of the West Virginia seed lots (3,516 gm. per 1000 full seeds). The relationship of seed weight to geographic origin may be more subtle than shown here.

The average number of cotyledons varied directly with the average weight of 1000 full seeds in both species and inversely with the latitude of the seed source. Red spruce seeds are heavier and they produce seedlings with more cotyledons than black spruce. This was true even when the average weight of 1000 full seeds of the lightest red spruce seed was compared to that of the heaviest black spruce; and when the lowest average number of cotyledons on red spruce was compared to the highest average for black spruce. The red spruce with the lowest seed weight and the lowest average number of cotyledons came from northern New Brunswick, near the northern limit of the range of this species. Part of these differences may be due to site as red spruce is generally found on richer sites than black spruce. It is possible that black spruce with heavier seeds, and seedlings that produce larger numbers of cotyledons, exist elsewhere.

The black spruce seed used here came from more uniform sites (all poor and wet) than red spruce. The variation in site quality may have influenced the seed weight of red spruce. Matyas (1954) found that Scots pine, Pinus sylvestris L. and Austrian pine, P. nigra Arnold growing on sandy soils produced heavier seeds than those growing on heavy soils. Marjai (1958) confirmed this relationship.

Morgenstern and Farrar (1964) present evidence that supports the theory that introgressive hybridization took place between red and black spruce in areas where their ranges overlap. Heavier seeds and seedlings with higher numbers of cotyledons may be characteristic of red spruce as shown by the seed and seedlings from West Virginia, beyond the range of black spruce, Lighter red spruce seed and seedlings with fewer cotyledons from the north, and black spruce with heavier seeds and seedlings with more cotyledons from the south may just be further evidence of introgressive hybridization of these species.

SUMMARY

This study was made using red and black spruce seeds from the Maritime Provinces along with two seed lots of red spruce from West Virginia. Red spruce seeds are heavier than those of black spruce and they produce seedlings with more cotyledons than black spruce seedlings. Both red and black spruce seed sources in the south produce heavier seeds which in turn produce seedlings with more cotyledons than seed sources further north. The possible influence of site on seed weight is considered along with the possible influence of introgressive hybridization of red and black spruce upon the seed weight and cotyledon numbers of these species.

REFERENCES

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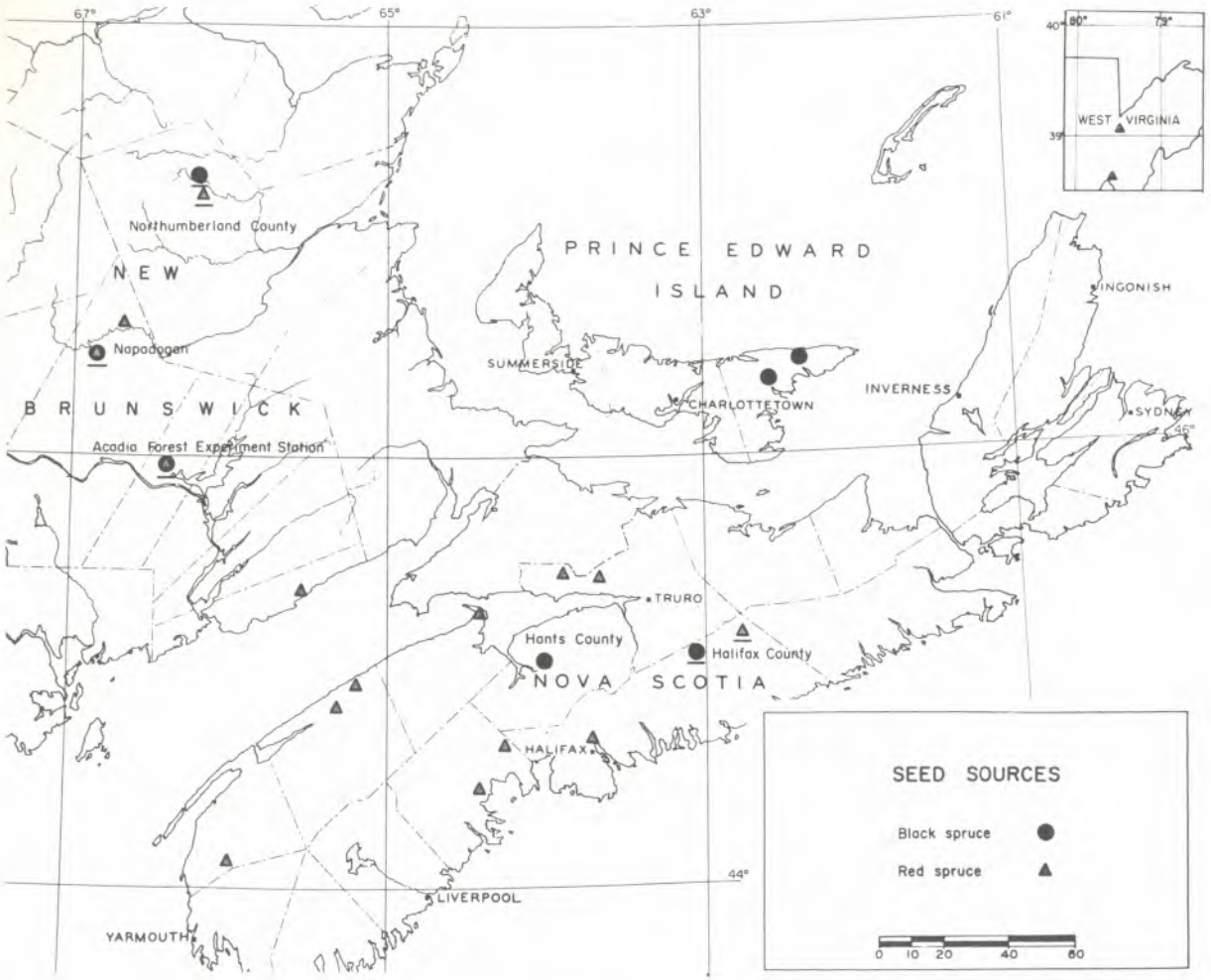

Figure 1.--Origins of seed lots. The underlined symbols indicate the origins of the red spruce and black spruce compared in tables 1 and 2.

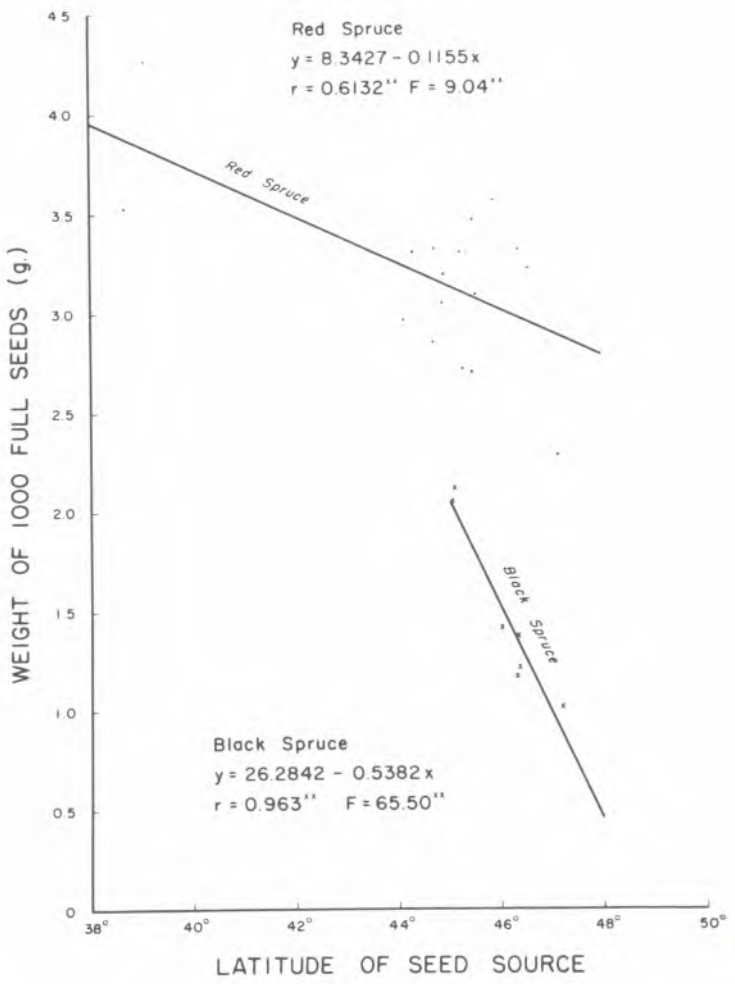

Figure 2.--Relationship of the average weight of 1000 full seeds to the latitude of the seed source.

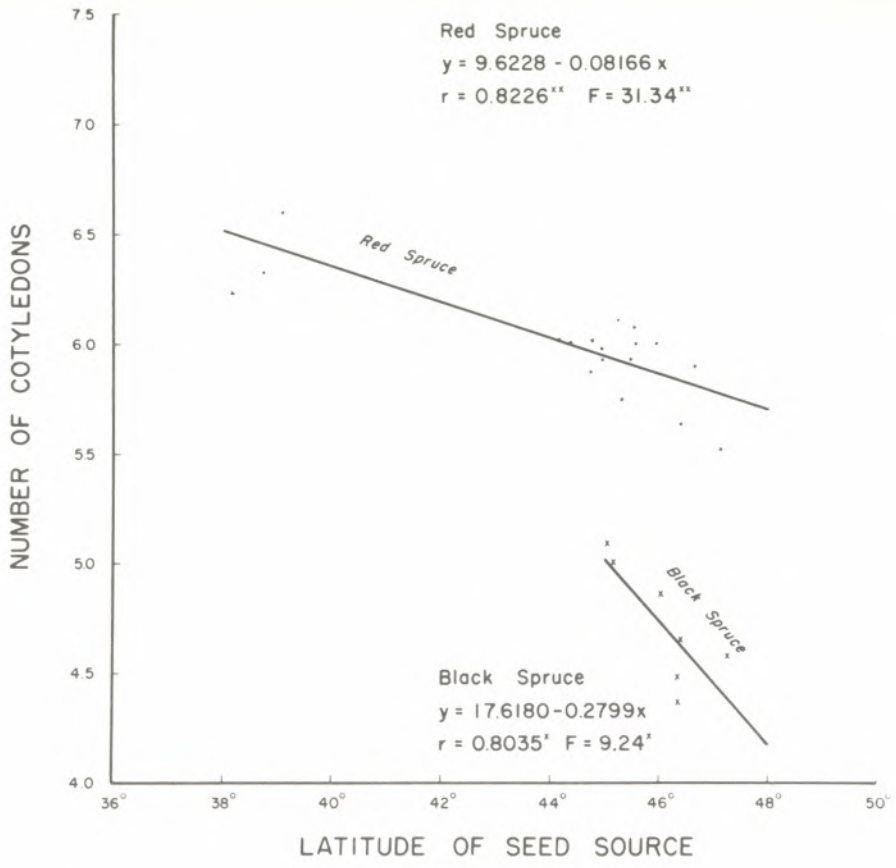

Figure 3.--Relationship of the average number of cotyledons to the latidue of the seed source.

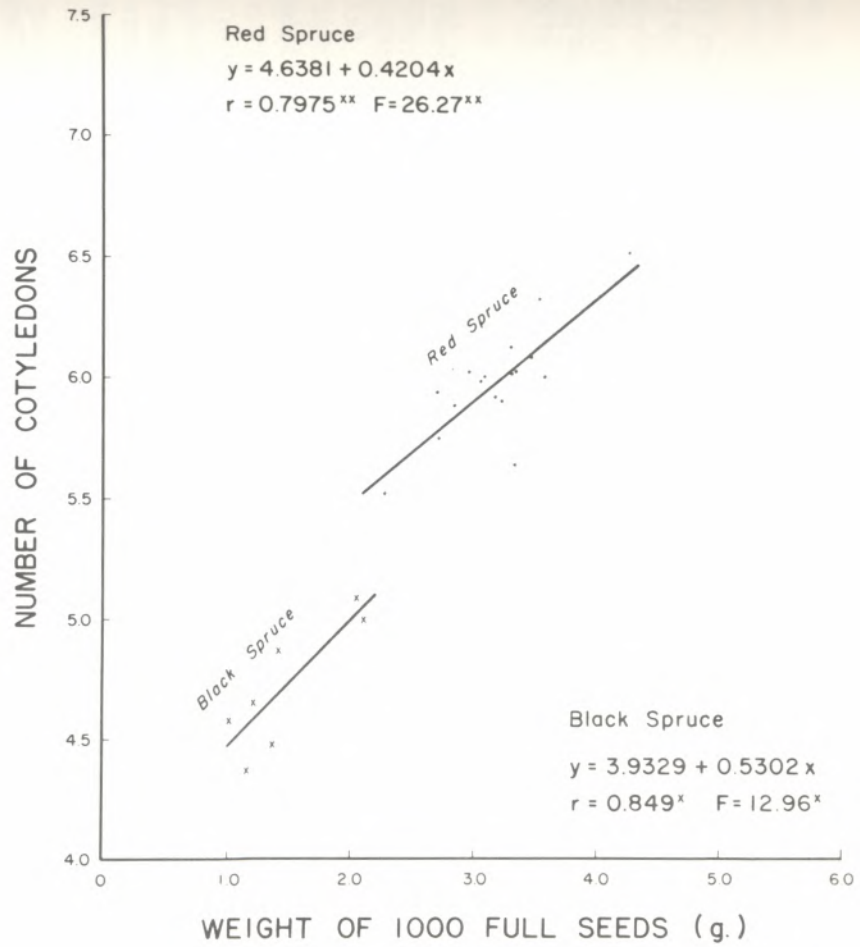

Figure 4.--Relationship of the average number of cotyledons to the average weight of 1000 full seeds.