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ASSESSMENT OF SOIL PROPERTIES AT THREE PROSPECTIVE TREE
NURSERY SITES, WHITEHORSE, YUKON TERRITORY, 1972.

Northern Forest Research Centre
Environment Canada
Edmonton

ASSESSMENT OF SOIL PROPERTIES AT THREE PROSPECTIVE TREE NURSERY
SITES, WHITEHORSE, YUKON TERRITORY, 1972
by Ivor K. Edwards *

Three samples of soil were submitted for analysis namely, River Flats, Old Burn and Hot Spring Road. Each sample was composed of about six inches of mineral soil below an organic layer but as a result of shaking en route to the laboratory, both layers had become mixed in varying degrees. Only in one case, Hot Spring Road, was it still possible to separate most of the mineral layer from the organic one. There was only partial success in separating mineral from organic material in the other two samples. Therefore, this report pertains to the mineral and organic fractions of the Hot Spring Road site but only to the mineral fractions of the River Flats and Old Burn sites.

Description of Samples

1. River Flats sample

The sample consisted of a thin moss layer over an organic layer that was around 1-2" thick. Immediately below this, the mineral soil consisted of a thin, dark brown sandy layer enriched with humus. This graded into fine, yellowish brown sand that was matted with roots and concretions of organic matter and at about six inches, this layer, in turn, graded into brown sand. There was no evidence of either mottling, gleying or salt accumulation.

White spruce cones and needles and aspen leaves were present.

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2. Old Burn

The sample consisted of a moss layer over a thin lichen layer that was partially mixed with the mineral soil. The latter consisted of very fine, yellowish brown sand that was matted with roots and contained flecks of ash along the root channels. There was no evidence of mottling, gleying or the accumulation of salts.

Cones and needles of lodgepole pine (P. contorta) were present.

3. Hot Spring Road

The sample consisted of a moss layer over a 3"-thick organic layer that contained decaying leaves and bits of wood. The mineral soil was a very fine yellowish brown sand that was also matted with roots and contained flecks of ash and organic matter along root channels. No mottling, gleying or carbonates were present.

Needles of lodgepole pine (P. contorta) were present in the duff layer which also carried *Arctostaphylos*, *Cladonia*, *Polytrichum*, *Marchantia* and a species of grass.

Physical Analysis of Soils

Physical analyses of the samples were comprised of mechanical analysis for texture and water holding capacity. The results are shown in Table 1.

Texture

Both River Flats and Old Burn are similar in texture - sandy loam - whereas Hot Spring Road is a loam. The amount of clay is similar in all three samples but Hot Spring Road has twice as much silt as the others. Although the sand content of Hot Spring Road is only two-thirds the amount in either of the other two samples, its drainage appears to be good. There was no evidence of mottling or gleying thus indicating that the water table is sufficiently deep for most of the year. Also, the plant species found on this site indicate well-drained conditions which are conducive to rapid warming in the spring.

However, only a relatively thin portion (4-6") of mineral soil was sampled at each site and subsurface drainage is not known. On a textural basis the River Flats and Old Burn sites are to be preferred for conifers.

Water Holding Capacity

The water holding capacity of a soil indicates the amount of water that is available to the plant. It is the difference between the amount held at field capacity (i.e. soil saturated but free of excess moisture) and the amount present at the wilting point¹, i.e. when plants can no longer obtain water from the soil.

The data in Table 1 indicate that Hot Spring Road has the highest water holding capacity, 18.9% (1.67 acre-inches). This is not surprising in view of its higher percentage of silt-plus-clay compared to the others. Finer particles contain a greater total pore space as

¹ In the laboratory, soils are equilibrated with negative pressures of 1/3 and 15 atmospheres to simulate field capacity and wilting point, respectively.

Table 1. Physical Analysis of Prospective Nursery Sites - Whitehorse, Yukon

Site	Sample	Sand %	Silt %	Clay %	Texture	% Moisture at		W.H.C. ³ %
						1/3 atm. ¹	15 atm. ²	
River Flats	mineral soil	68.00	20.60	11.40	Sandy Loam	21.94	5.82	16.22
Old Burn	mineral soil	67.27	22.40	10.33	Sandy Loam	17.66	3.84	13.82
Hot Spring Road	org.layer mineral soil	- 44.63	- 42.38	- 12.99	- Loam	- 23.04	- 4.14	- 18.90

¹ Soil moisture held at this tension simulates field capacity or removal of excess moisture from a saturated soil.

² Soil moisture held at this tension simulates wilting point or that point below which no water is available to the plant.

³ Water holding capacity is the difference between the moisture content at 1/3 atm. and that at 15 atm. and is the amount of water available to the plant.

well as surface area for absorption. The water holding capacity of River Flats while lower, 16.2% (1.43 acre-inches), is not significantly different. This could be due to a greater proportion of very fine sand at this site compared to Hot Spring Road. The Old Burn site had the lowest water holding capacity, 13.8% or 1.22 acre-inches.

When the water holding capacity is considered in terms of acre-inches it is apparent that all three sites are deficient in their ability to meet the water requirements of tree seedlings and irrigation will be necessary. An adequate supply of moisture for any plant pre-supposes that the soil surrounding the roots are at, or close to, field capacity (1/3 atm. tension).

It is not possible to advise on an irrigation schedule without climatic data for the area during the growing season. Shorter and more frequent irrigation periods are advised in early season. Soil washing, by way of surface run-off, is to be avoided.

Quality of Irrigation Water

Good quality irrigation water is essential. It should be low in soluble salts, preferably having an electrical conductivity of less than 0.250 millimhos/cm. The sodium content should be such that the sodium adsorption ratio does not exceed 10. The boron content should be less than 0.5 ppm. Ideally, the pH should be around 6.0. Chemical analysis of the irrigation water supply is therefore strongly advised prior to its use.

Chemical Analysis of Soils

Table 2 shows the results of the chemical analysis of mineral soil of River Flats and Old Burn and both the organic and mineral fractions of Hot Spring Road.

Soil Reaction - pH

Both River Flats and Old Burn samples were neutral. On the other hand the organic and mineral fractions of Hot Spring Road were moderately acid (pH 5.75) and slightly acid (pH 6.20), respectively. By mixing the humus with the mineral fraction, the pH of the latter was reduced to 5.90, i.e. moderately acid.

In view of the optimum pH requirement of 5.5 for conifers, the Hot Spring Road site might be favored. However, pH can be suitably lowered by the application of sulphur and so other chemical characteristics have to be considered. In order to benefit from the acid humic material it should be plowed into the mineral soil during preparation of the selected site. Of course, it is quite possible that the organic layers of the other two sites might have been sufficiently acidic to adequately lower, through mixing, the pH of the mineral soil beneath them. However, as mentioned earlier, the sampling technique employed did not lend itself to a proper separation of the organic and mineral fractions in the laboratory.

Conductivity

The total salt concentration in the samples as indicated by

Table 2. Chemical Analysis of Prospective Runway Sites - Whitehorse, Yukon

Site	Sample	pH	Conductivity ($\mu\text{mhos/cm}$)	O.M. ¹ (%)	$\text{NO}_3\text{-N}$ (lbs per acre)	Avail. P	K	Exchangeable Cations (me/100g)					C.E.C. ² (me/100g)	B.S. ³ (%)
								Ca	Mg	Na	K	H		
River Flats	Mineral Soil	7.00	0.112	2.27	4.9	114.4	172.6	9.96	21.37	0.88	0.22	1.10	33.53	90.72
Old Burn	Mineral Soil	6.85	0.097	1.63	4.9	64.2	201.0	4.83	9.43	0.81	0.26	0.88	16.21	94.57
Hot Spring Road	Org. Layer	5.75	0.190	45.83	7.0	18.3	258.1	28.51	80.82	0.88	1.65	10.96	122.42	31.57
	Mineral Soil	6.20	0.128	1.07	6.0	60.7	223.4	4.50	16.57	0.80	0.29	1.76	23.92	92.64

¹ Organic Matter.

² Cation exchange capacity is total exchangeable cations.

³ Base saturation, % is $\frac{(\text{Ca} + \text{Mg} + \text{Na} + \text{K})}{\text{C.E.C.}} \times 100$

electrical conductivity is quite low and should present no salinity hazard to tree seedlings. An electrical conductivity of 4.0 millimhos/cm is generally associated with the maximum level of salinity that most crops can tolerate before yields are restricted.

Organic Matter

Results indicate that the mineral soil from each site is low in organic matter. Organic matter content is an indication of the level of natural fertility and 5-6 per cent is representative of the plow layer of most agricultural soils.

There probably is insufficient precipitation to leach humus from the organic zone into the underlying mineral soil. Although the data show that mineral soil from River Flats and Old Burn were higher in organic matter than that from Hot Spring Road it must be pointed out that only in the latter case was there a complete separation of organic and mineral material. Thus, it is quite possible that the values shown for River Flats and Old Burn reflect some contamination with humus.

However, the organic matter content of the organic layer at the Hot Spring Road site is sufficiently high to be of value to the mineral soil when both are mixed. Plowing-in of the humic material is therefore most advisable in the preparation of any of these sites. The rate of decomposition of organic matter is generally most rapid immediately following plowing and nutrients are released to the mineral soil.

Nitrogen

Nitrate nitrogen is an indication of the level of microbial

activity and the availability of nitrogen for plant use. Table 2 shows that nitrate nitrogen is extremely low in the mineral soils from all sites (5-6 lbs/acre) and in the humus layer that was analysed (7 lbs/acre). It is possible that owing to relatively cool summers, the bacterial decomposition of organic material is restricted. Thus the nitrogen present is being held in an organic form instead of being converted to an inorganic one in which it would be available to the plant.

An application of nitrogen as ammonium nitrate at a rate of 100 lbs N per acre (300 lbs ammonium nitrate per acre) is recommended for each of the first two years of operation on any of these sites. Subsequently the annual application may be reduced to 50 lbs N per acre (150 lbs ammonium nitrate per acre)

Phosphorus

The level of plant-available phosphorus is adequate at all three sites and application of phosphorus would be unnecessary during the initial year of operation at any of the sites. The level of phosphorus at River Flats, 114 lbs/acre, is almost twice that at either of the other sites and this would be sufficient for the first two years of cropping at least. The minimum level of phosphorus should be around 50 lbs per acre and even then, the soil pH should be below pH6.0 for maximum availability of this phosphorus. It would be advisable to check the soil phosphorus level at the end of the second growing season.

Potassium

Adequate levels of potassium are present at all sites to satisfy the requirements of a conifer nursery. Having sustained natural growth for some years, it appears that the soil minerals present are able to release sufficient potassium to replace that used by plants. Data from Hot Spring Road indicate that potassium in the humus layer is also adequate. It can be assumed that the other two sites would be similar in this respect since the levels in the mineral soil are high. In order to benefit from the high potassium in the humus, it would be advisable to mix the humus into the mineral soil.

Exchangeable Cations and Exchange Capacity

Among the exchangeable cations, the predominant ion at all sites is magnesium rather than calcium which, in many soils, is the more common. However, both calcium and magnesium, the more important exchangeable cations, are in sufficient supply to satisfy plant requirements. Calcium and magnesium dominate the exchangeable bases.

Another indication of the suitability of these sites for a nursery is the cation exchange capacity. River Flats is highest with 33.53 m.e./100 g compared to 23.92 and 16.21 m.e./100 g for Hot Spring Road and Old Burn, respectively. Since all three sites have sufficient exchangeable bases for plant needs, the River Flats site is to be favored on account of its high cation exchange capacity. This indicates that when fertilized, the soil at this site will be able to retain more nutrients for a longer duration. The soil at this site is also highest

in percentage base saturation 96.7% and this is of advantage when the soil is mixed with the more acid organic layer on the surface. In addition, the cation exchange capacity of the resulting mixture would be higher than that of the mineral soil itself. This is so because, as the Hot Spring Road example shows, the exchange capacity of humic material is always much greater than that of mineral soil.

Selection of Nursery Site

On the basis of physical and chemical analyses of the samples submitted, the sites can be ranked in order of their general suitability, as follows:

First	River Flats
Second	Hot Spring Road
Third	Old Burn

River Flats is superior to the other two sites on the basis of cation exchange capacity and exchangeable cation and phosphorus. Its texture affords less water holding capacity than Hot Spring Road but since irrigation will be necessary the availability of soil moisture is assured. The neutral pH of River Flats soil, although higher than that of the other soils, can be suitably amended.

However, it should be re-emphasized that these conclusions have been based on an inadequate number of improperly sampled soils. The contamination of soil horizons cannot be ruled out. Furthermore, the author is without any knowledge concerning the gross characteristics, such as topography, drainage and sub-soil conditions, of the sites

concerned. These are extremely important aspects of the site selection process. Therefore the conclusions that have been drawn are all subject to these considerations.

Recommendations

1. Plow the surface litter and humus into the mineral soil.
2. Plow in sulphur at the rate of 500 lbs. per acre in preparing the seedbed.
3. For each of the first two years, apply 300 lbs. per acre of ammonium nitrate (33-0-0). In each subsequent year apply only 150 lbs. per acre.
4. No application of phosphorus or potassium is necessary at the present time but arrange to have the soil tested at the end of the second growing season.
5. Once the ground is broken by plowing, the rate of decomposition of organic matter will increase rapidly and, with continuous cropping of the area, it could be depleted in a few years. It would be advisable to have a supply of peat from which to replenish the organic matter in the soil.
6. Check the quality of the irrigation water.
7. Irrigate judiciously. Frequent, short wetting periods are always to be preferred on well drained soils in order to avoid undue leaching of soil nutrients.
8. In choosing a location, it is most advisable to select fairly level ground (maximum slope 1-2 per cent). Avoid basins where "frost pockets" are likely to occur.

9. Locate close to or slightly south of the area in which nursery stock is to be field-planted. In this way climatic conditions at the field site will be more suitable for the lifted stock.

SUMMARY

On the basis of physical and chemical analyses of the three samples submitted, the River Flats site is recommended above the others. It is sandy loam in texture and neutral in pH. Its cation exchange capacity, phosphorus and potassium are adequate for a conifer nursery. Nitrogen is very low on all sites. It is recommended that in the preparation of this site, surface humus and 500 lbs. per acre of sulphur be plowed into the mineral soil. 300 lbs. per acre of ammonium nitrate should be applied in each of the first two years. Judicious irrigation with good quality water is advised.

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