Supplemental Material

**Appendix 1** Chemical characteristics of the substrate.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Chemical characteristics | Units | Mean in P1 (n = 3) | Mean in P2 (n = 3) | Mean in P3 (n = 3) | \*Legal threshold |
| Conductivity | µS/cm | 204.2 | 243 | 210 | - |
| Organic carbon | % | 9.03 | 16.35 | 7.05 |  |
| Nitrogen | % | 0.34 | 0.52 | 0.19 | - |
| pH | - | 3.82 | 3.70 | 3.88 | - |
| Aluminium | µg/g | 5,305 | 4,172 | 5,980 |  |
| Arsenic | µg/g | 3.82 | 4.04 | 2.38 | 30 |
| Boron | µg/g | < 0.50 | < 0.50 | < 0.50 |  |
| Barium | µg/g | 68.58 | 66 | 42 |  |
| Beryllium | µg/g | < 0.20 | < 0.20 | < 0.20 |  |
| Calcium | µg/g | 1,665 | 2,328 | 1,266 | - |
| Cadmium | µg/g | 0.68 | 1.34 | 0.43 | 5 |
| Cobalt | µg/g | 2.03 | 2.16 | 3.12 | 50 |
| Chromium | µg/g | 10.59 | 8.85 | 14.93 | 250 |
| Copper | µg/g | 13.29 | 19.99 | 14.40 | 100 |
| Iron | µg/g | 7,125 | 5,151 | 7,898 |  |
| Potassium | µg/g | 384 | 571 | 390 | - |
| Magnesium | µg/g | 1,314 | 1,340 | 2,088 | - |
| Manganese | µg/g | 227 | 156 | 108 | 1000 |
| Molybdenum | µg/g | < 5.0 | < 5.0 | < 5.0 | 10 |
| Sodium | µg/g | 82.2 | 115 | 60.16 | - |
| Nickel | µg/g | 6.72 | 10.28 | 10.48 | 100 |
| Phosphorus | µg/g | 363 | 453 | 405 | - |
| Lead | µg/g | 18 | 33.41 | 13.66 | 500 |
| Sulfur | µg/g | 378 | 594 | 319 | - |
| Selenium | µg/g | < 2.0 | < 2.0 | < 2.0 | 3 |
| Silicon | µg/g | 14 | 17.4 | < 5.0 |  |
| Strontium | µg/g | 9 | 12 | 7.4 | - |
| Titanium | µg/g | 472 | 275 | 335 |  |
| Thallium | µg/g | < 5.0 | < 5.0 | < 5.0 |  |
| Vanadium | µg/g | 16 | 10 | 14.46 |  |
| Zinc | µg/g | 26.23 | 34.03 | 24.30 | 500 |
| Total Organic Carbon | % | 7.61 | 15.49 | 6.66 | - |

Note: Total elements are presented here.

\*: Government of Quebec (2017).

P1=Plot 1; P2=Plot 2; P3= Plot 3.

**Appendix 2** Different stages of the root study and the location of the trenchesaround each measured tree.

Une image contenant texte, capture d’écran, sapin, plante

Description générée automatiquement

**Sand**

**Appendix 3** A summary of statistical treatments and results

Parametric ANOVA

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Variable\* | Factor | Df | Sum Sq | Mean Sq | F value | p-value |
| Total root density by trench (square root) | Trench distance from tree trunk | 4.00 | 24.57 | 6.14 | 6.32 | 0.0001312 |
| Total root occurrence by trench | Trench distance from tree trunk | 4.00 | 97613.11 | 24403.28 | 7.01 | 0.0000450 |

Estimated marginal means with Šidák adjustment

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Distance (cm) | Df | t.ratio | p.value |
| Total root density by trench | 50 - 100 | 108 | 2.07561892 | 0.23821114 |
| 50 - 150 | 108 | 3.22684938 | 0.01403907 |
| 100 - 150 | 108 | 1.17442246 | 0.76590574 |
| Total root occurrence by trench | 50 - 100 | 112 | 2.00233226 | 0.2716583 |
| 50 - 150 | 112 | 2.08314414 | 0.23464567 |
| 100 - 150 | 112 | 0.06079429 | 0.99999686 |

Non parametric Kruskall - Wallis

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Factor | Stat KW | Df | p-value |
| Max. rooting depth by trench | Trench distance from tree trunk | 27.0691021540536 | 4 | 0.0000192 |

Dunn test

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Distance | Z | P.unadj | P.adj |
| Max. rooting depth by trench | 100cm - 150cm | 1.647827827 | 0.09938801 | 0.141982867 |
| 100cm - 50cm | -0.91547667 | 0.35994144 | 0.399934938 |
| 150cm - 50cm | -2.518457746 | 0.011787 | 0.023574005 |

Kruskal-Wallis

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Variable | Factor | Depth | n observ | Stat KW | Df | p-value |
| Root density | Trench distance from tree trunk | 0-5 | 106 | 2.74107828 | 4 | 0.6020000000 |
| 5-10 | 109 | 6.10703209 | 4 | 0.1910000000 |
| 10-15 | 113 | 3.85040842 | 4 | 0.4270000000 |
| 15-20 | 111 | 11.5736917 | 4 | 0.0208000000 |
| 20-25 | 112 | 20.4085364 | 4 | 0.0004150000 |
| 25-30 | 114 | 15.7348946 | 4 | 0.0034000000 |
| 30-35 | 112 | 24.300664 | 4 | 0.0000695000 |
| 35-40 | 114 | 10.295366 | 4 | 0.0357000000 |
| 40-45 | 106 | 17.5293911 | 4 | 0.0015200000 |
| 45-50 | 109 | 28.0451313 | 4 | 0.0000122000 |
| 50-55 | 107 | 18.8815269 | 4 | 0.0008290000 |
| 55-60 | 110 | 43.7311954 | 4 | 0.0000000073 |
| Root occurrence | Trench distance from tree trunk | 0-5 | 117 | 1.75048658 | 4 | 0.7820000000 |
| 5-10 | 116 | 6.55540831 | 4 | 0.1610000000 |
| 10-15 | 120 | 4.84959135 | 4 | 0.3030000000 |
| 15-20 | 118 | 10.4941919 | 4 | 0.0329000000 |
| 20-25 | 120 | 17.1210268 | 4 | 0.0018300000 |
| 25-30 | 117 | 14.5446788 | 4 | 0.0057500000 |
| 30-35 | 112 | 14.9671819 | 4 | 0.0047700000 |
| 35-40 | 116 | 10.0432426 | 4 | 0.0397000000 |
| 40-45 | 112 | 15.4678904 | 4 | 0.0038200000 |
| 45-50 | 111 | 28.9952312 | 4 | 0.0000078300 |
| 50-55 | 108 | 20.1720764 | 4 | 0.0004620000 |
| 55-60 | 112 | 47.7673841 | 4 | 0.0000000011 |

Dunn Test

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Variable | Depth (cm) | Trench distance from tree trunk | Z | P. unadj | P. adj |
| Root density | 0-5 | 100cm - 150cm | 0.52634257 | 0.59865021 | 0.85521459 |
| 100cm - 50cm | -0.64338630 | 0.51997347 | 0.86662246 |
| 150cm - 50cm | -1.18486943 | 0.23606907 | 1.00000000 |
| 5-10 | 100cm - 150cm | 1.57967523 | 0.11418126 | 0.38060421 |
| 100cm - 50cm | 0.17985431 | 0.85726694 | 1.00000000 |
| 150cm - 50cm | -1.40620832 | 0.15966227 | 0.26610379 |
| 10-15 | 100cm - 150cm | -0.10455403 | 0.91672969 | 1.00000000 |
| 100cm - 50cm | 1.29447341 | 0.19550195 | 0.65167316 |
| 150cm - 50cm | 1.38285833 | 0.16670831 | 1.00000000 |
| 15-20 | 100cm - 150cm | -1.14127873 | 0.25375395 | 0.42292325 |
| 100cm - 50cm | -1.83707943 | 0.06619817 | 0.16549542 |
| 150cm - 50cm | -0.70105666 | 0.48326766 | 0.60408457 |
| 20-25 | 100cm - 150cm | 0.36635874 | 0.71409740 | 0.71409740 |
| 100cm - 50cm | -1.70874508 | 0.08749818 | 0.14583030 |
| 150cm - 50cm | -2.05242442 | 0.04012843 | 0.08025687 |
| 25-30 | 100cm - 150cm | 1.37715684 | 0.16846376 | 0.24066252 |
| 100cm - 50cm | -1.40704631 | 0.15941366 | 0.26568943 |
| 150cm - 50cm | -2.79877664 | 0.00512966 | 0.01709887 |
| 30-35 | 100cm - 150cm | -0.05141879 | 0.95899181 | 0.95899181 |
| 100cm - 50cm | -0.91941000 | 0.35788116 | 0.51125880 |
| 150cm - 50cm | -0.87772070 | 0.38009531 | 0.42232812 |
| 35-40 | 100cm - 150cm | -1.04135000 | 0.29771314 | 0.49618857 |
| 100cm - 50cm | -2.03984157 | 0.04136611 | 0.13788703 |
| 150cm - 50cm | -1.00977432 | 0.31260343 | 0.44657633 |
| 40-45 | 100cm - 150cm | -0.89056931 | 0.37316027 | 0.41462252 |
| 100cm - 50cm | -2.13349700 | 0.03288398 | 0.08220994 |
| 150cm - 50cm | -1.24823784 | 0.21194397 | 0.26492996 |
| 45-50 | 100cm - 150cm | 1.03879955 | 0.29889797 | 0.37362246 |
| 100cm - 50cm | -0.99064232 | 0.32186026 | 0.35762251 |
| 150cm - 50cm | -1.99748050 | 0.04577301 | 0.06539002 |
| 50-55 | 100cm - 150cm | 2.98926031 | 0.00279654 | 0.01398269 |
| 100cm - 50cm | 0.37301763 | 0.70913532 | 1.00000000 |
| 150cm - 50cm | -2.54997699 | 0.01077300 | 0.02154601 |
| 55-60 | 100cm - 150cm | 1.87510270 | 0.06077860 | 0.08682657 |
| 100cm - 50cm | -3.47164440 | 0.00051728 | 0.00129320 |
| 150cm - 50cm | -5.30614167 | 0.00000011 | 0.00000037 |
| Root occurrence | 0-5 | 100cm - 150cm | -0.46917834 | 0.63894217 | 1.00000000 |
| 100cm - 50cm | -1.24072914 | 0.21470583 | 1.00000000 |
| 150cm - 50cm | -0.79863096 | 0.42450443 | 1.00000000 |
| 5-10 | 100cm - 150cm | 0.59386484 | 0.55260252 | 0.69075315 |
| 100cm - 50cm | 1.07219991 | 0.28363025 | 0.56726050 |
| 150cm - 50cm | 0.48468675 | 0.62789857 | 0.69766508 |
| 10-15 | 100cm - 150cm | 0.01255680 | 0.98998139 | 0.98998139 |
| 100cm - 50cm | 0.92501768 | 0.35495671 | 0.50708101 |
| 150cm - 50cm | 0.91246088 | 0.36152615 | 0.45190769 |
| 15-20 | 100cm - 150cm | -0.34868809 | 0.72732349 | 0.80813721 |
| 100cm - 50cm | -0.81748308 | 0.41365242 | 0.59093202 |
| 150cm - 50cm | -0.46005161 | 0.64547918 | 0.80684897 |
| 20-25 | 100cm - 150cm | 0.13466031 | 0.89288046 | 0.89288046 |
| 100cm - 50cm | -0.82058624 | 0.41188199 | 0.45764665 |
| 150cm - 50cm | -0.95524655 | 0.33945303 | 0.42431629 |
| 25-30 | 100cm - 150cm | 0.74975445 | 0.45340261 | 0.50378068 |
| 100cm - 50cm | -1.53437666 | 0.12493702 | 0.24987403 |
| 150cm - 50cm | -2.33546631 | 0.01951907 | 0.06506358 |
| 30-35 | 100cm - 150cm | 0.07287947 | 0.94190203 | 0.94190203 |
| 100cm - 50cm | 0.52068099 | 0.60258902 | 0.75323627 |
| 150cm - 50cm | 0.45556180 | 0.64870512 | 0.72078347 |
| 35-40 | 100cm - 150cm | -1.02565655 | 0.30505350 | 0.50842251 |
| 100cm - 50cm | -1.96940752 | 0.04890631 | 0.16302104 |
| 150cm - 50cm | -0.95441517 | 0.33987353 | 0.42484191 |
| 40-45 | 100cm - 150cm | -0.48832190 | 0.62532185 | 0.62532185 |
| 100cm - 50cm | -1.47673250 | 0.13974736 | 0.23291226 |
| 150cm - 50cm | -0.97806047 | 0.32804442 | 0.41005552 |
| 45-50 | 100cm - 150cm | 0.84628793 | 0.39739214 | 0.44154682 |
| 100cm - 50cm | -1.08471476 | 0.27804801 | 0.34756001 |
| 150cm - 50cm | -1.91940113 | 0.05493359 | 0.07847655 |
| 50-55 | 100cm - 150cm | 2.85384805 | 0.00431932 | 0.00863864 |
| 100cm - 50cm | -0.08103981 | 0.93541029 | 1.00000000 |
| 150cm - 50cm | -2.90134519 | 0.00371564 | 0.01238548 |
| 55-60 | 100cm - 150cm | 1.82557798 | 0.06791385 | 0.09701979 |
| 100cm - 50cm | -3.67995244 | 0.00023328 | 0.00058319 |
| 150cm - 50cm | -5.49897344 | 0.00000004 | 0.00000013 |

# Parametric ANOVA of RLD

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Variable\* | Factor | Df | Sum Sq | Mean Sq | F value | p-value |
| RLD | Depth | 2 | 2.465 | 1.232 | 33.31 | <0.00001 |

# Post hoc

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Variable | Depth | Difference | Lower | Upper | P.adj |
| RLD | 2-1 | 0.26937059 | 0.1617596 | 0.376981609 | 0.0000001 |
| 3-1 | -0.09346512 | -0.1919652 | 0.005034994 | 0.0667513 |
| 3-2 | -0.36283571 | -0.4704467 | -0.255224693 | 0.0000000 |

Group 3: 30 cm in the silt; Group 2: 10 cm above the silt; Group 1: 10 cm in the silt.

Regression linear Model

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameters | Estimated Std. | Error | t value | p value |
| Intercept | 0.15699 | 0.02933 | 5.353 | <0.0001 |
| Group 2 | 0.26937 | 0.04532 | 5.944 | <0.0001 |
| Group 3 | -0.09347 | 0.04148 | -2.253 | 0.0262 |

Parametric t-test of Student to compare R1 and R2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable\* | Factor | Df | t value | p-value |
| Ratio | Depth | 62.357 | 0.36102 | 0.7193 |