Supplementary Materials for:

Contrasting Root System Structure and Belowground Interactions between Black Spruce (*Picea mariana* (Mill.) B.S.P) and Trembling Aspen (*Populus tremuloides* Michx) in Boreal Mixedwoods of Eastern Canada

Claudele Ghotsa Mekontchou[1,*], Daniel Houle[2,3], Yves Bergeron[1], Igor Drobyshev[1,4]

[1] Chaire industrielle CRSNG-UQAT-UQAM en aménagement forestier durable, Institut de recherche sur les forêts, Université du Québec en Abitibi-Témiscamingue (UQAT), 445 boul. de l'Université, Rouyn-Noranda, Québec, J9X 5E4, Canada

[2] Direction de la Recherche Forestière, Ministère des Forêts, de la Faune et des Parcs du Québec, 2700 rue Einstein, Sainte-Foy, Québec, G1P 3W8, Canada

[3] Consortium on Regional Climatology and Adaptation to Climate Change (Ouranos), 550 rue Sherbrooke Ouest, Montreal, Québec, H3A 1B9, Canada

[4] Southern Swedish Forest Research Centre, Swedish University of Agricultural Sciences, P.O. Box 49, 230 53 Alnarp, Sweden

[*] Correspondence: claudele.ghotsamekontchou@uqat.ca

Table S1. Summary of soil chemical properties (mean and SEM). Each stand type was replicated three times. FF, Min1 and Min2 refer to organic horizon, mineral soil at 0-15 cm and mineral soil at 15-30 cm, respectively.

Properties	Soil layer	Stand type		
		Pure spruce	Mixed (spruce + aspen)	Pure aspen
Total C (g kg^{-1})	FF	341.66 ± 32.8 ^{aA}	323.83 ± 23.83 ^{aA}	263.33 ± 60.76 ^{bA}
	Min1	23.5 ± 8.03 ^{aB}	24.33 ± 5.78 ^{aB}	20.41 ± 5.86 ^{bB}
	Min2	5.58 ± 02.96 ^{aC}	7.16 ± 3.12 ^{aC}	5.91 ± 1.66 ^{aC}
Total N (g kg^{-1})	FF	8.73 ± 1.68 ^{aA}	12.21 ± 1.41 ^{bA}	13.14 ± 3.63 ^{bA}
	Min1	1.09 ± 0.55 ^{aB}	1.25 ± 0.28 ^{aB}	1.20 ± 0.38 ^{aB}
	Min2	0.3 ± 0.17 ^{aC}	0.4 ±0.11 ^{aC}	0.35 ± 0.06 ^{aC}
C:N ratio	FF	40.13 ± 8.62 ^{aA}	26.91 ± 4.94 ^{bA}	20.54 ± 5.35 ^{cA}
	Min1	22.65 ± 3.18 ^{aB}	19.42 ± 0.43 ^{bB}	17.36 ± 1.64 ^{cA}
	Min2	19 ± 1.01 ^{aB}	17.18 ± 3.34 ^{aB}	16.91. ± 1.93 ^{aA}
pH (H_2O)	FF	3.93 ± 0.27 ^{aA}	4.68 ± 0.23 ^{bA}	5.15 ± 0.25 ^{cA}
	Min1	4.74 ± 0.13 ^{aB}	5.02 ± 0.23 ^{bB}	5.43 ± 0.51 ^{cA}
	Min2	5.42 ± 0.36 ^{aC}	5.44 ± 0.3 ^{aC}	6.11 ± 0.8 ^{bB}
NH_4 (mg kg^{-1})	FF	28.66 ± 5.9 ^{aA}	35.58 ± 7.4 ^{bA}	49.08 ± 20.69 ^{cA}
	Min1	2.66 ± 0.28 ^{aB}	4 ± 1.25 ^{bB}	3.58 ± 1.01 ^{bB}
	Min2	2.08 ± 0.14 ^{aB}	2 ± 0.75 ^{aC}	2.5 ± 0.5 ^{aC}
Exchangeable P (mg kg^{-1})	FF	93.58 ± 31.9 ^{aA}	94.16 ± 58.10 ^{aA}	68.58 ± 28.58 ^{aA}
	Min1	7.33 ± 1.75 ^{aB}	6.08 ± 1.01 ^{aB}	5.66 ± 0.57 ^{aB}
	Min2	12.33 ± 4.88 ^{aC}	9.66 ± 6.13 ^{aB}	8.08 ± 7.3 ^{aB}
Exchangeable K (mg kg^{-1})	FF	473.33 ± 73.43 ^{aA}	520.41 ± 101.5 ^{aA}	480.33 ± 132.93 ^{aA}
	Min1	76.75 ± 28.36 ^{aB}	118.16 ± 41.64 ^{bB}	144.58 ± 58.13 ^{bB}
	Min2	99.5 ± 24.6 ^{aC}	93.83 ± 18 ^{aB}	121.75 ± 27.94 ^{bB}
CEC (meq $100g^{-1}$ soil)	FF	127.95 ± 3.32 ^{aA}	114.65 ± 3.6 ^{bA}	107.61 ± 6.86 ^{cA}
	Min1	28.64 ± 5.36 ^{aB}	26.22 ± 4.9 ^{aB}	25.88 ± 3.38 ^{aB}
	Min2	19.10 ± 2.75 ^{aC}	19.5 ± 2.9 ^{aC}	20.13 ± 1.9 ^{aC}
Organic layer depth (cm)		10.75 ± 2.19 ^{a}	9.13 ± 0.99 ^{a}	6.78 ± 2.11 ^{b}

Differences among stand types for each soil layer and differences among soil layers within each stand type were tested using a one-way analysis of variance. Statistical differences among pairwise comparisons at $p = 0.05$ are denoted by lowercase letters for significant differences among stand types, and capital letters for significant differences among soil layers. pH, total carbon (C), total nitrogen (N), ammonium (NH_4) and C to N ratio were determined as in Carter & Gregorich [60] whereas exchangeable phosphorus (P), exchangeable potassium (K) and cation exchange capacity (CEC) were determined by Mehlich 3 extraction technique [61].

Table S2. Effect *p.values* of the analysis of covariance for spruce. *p. values* for the effect of stand type test the similarity of the linear relationship between the FRB and the variation of each soil property between pure and mixed stands, and similarly for the RDMC. *p.values* for mixed effect (interaction between stand type and soil property) test the homogeneity of the response of FRB and RDMC to the variation of each soil property in different soil horizon between pure and mixed stands. Significant *p.values* are in bold. FF, Min1 and Min2 refer to organic, mineral soil at 0-15 cm and mineral soil at 15-30 cm, respectively. In sources of variations, ST and ST x SP refers to stand type and interaction between stand type and soil property, respectively.

	Black Spruce							
	Root weight density				Root dry matter content			
	FRB FF		FRB Min1		RDMC FF		RDMC Min1	
Sources	ST (Similarity)	ST x SP (Mixed effect)	ST (Similarity)	ST x SP (Mixed effect)	ST (Similarity)	ST x SP (Mixed effect)	ST (similarity)	ST x SP (Mixed effect)
Total carbon								
FF	**0.029**	0.206	**0.001**	0.709	**0.035**	**0.036**	**<0.001**	0.345
Min1	**0.006**	0.257	**<0.001**	**0.006**	**0.032**	0.343	**<0.001**	0.397
Total nitrogen								
FF	0.959	0.418	0.376	**<0.001**	0.64	0.199	**0.003**	0.543
Min1	**0.015**	0.444	**<0.001**	**0.03**	**0.042**	0.377	**<0.001**	0.354
C:N ratio								
FF	0.291	0.445	0.344	0.116	0.253	**0.032**	**0.001**	0.887
Min1	0.209	0.335	**0.046**	**0.025**	**0.065**	0.579	**0.001**	0.637
Ammonium								
FF	**0.022**	**<0.001**	**0.003**	**0.011**	**0.002**	0.409	**<0.001**	0.726
Min1	**0.011**	0.425	**0.003**	0.441	**0.018**	0.832	**0.005**	0.812
Phosphorus								
FF	**<0.001**	**<0.001**	**<0.001**	0.128	0.027	0.210	**<0.001**	0.494
Min1	**0.018**	0.510	**0.003**	0.503	0.053	0.315	**<0.001**	0.333
pH (H_2O)								
FF	0.242	0.251	0.625	**0.018**	0.641	0.103	**0.005**	0.717
Min1	0.153	0.888	**0.005**	**<0.001**	0.548	0.456	**0.001**	0.428
Potassium								
FF	**0.008**	0.422	**<0.001**	**0.002**	0.018	0.280	**0.001**	0.964
Min1	**0.042**	**0.003**	**0.007**	**0.006**	0.009	0.774	**0.002**	0.718
CEC								
FF	**0.007**	**0.046**	**0.004**	**0.034**	0.113	0.960	**0.004**	0.906
Min1	**0.002**	0.122	**<0.001**	**0.006**	0.052	0.924	**<0.001**	0.552
Organic layer depth	**0.003**	0.589	**<0.001**	0.082	0.071	0.158	**0.001**	0.965

Table S3. Effect *p.values* of the analysis of covariance for aspen.

	Trembling aspen											
	Root weight density						Root dry matter conten					
	FRB FF		FRB Min1		FRB Min2		RDMC FF		RDMC Min1		RDMC Min2	
Sources	ST (Similarity)	ST x SP (Mx effect)	ST (Similarity)	ST x SP (Mx effect)	ST Similarity	ST x SP (Mx effect)	ST (Similarity)	ST x SP (Mx effect)	ST (Similarity)	ST x SP (Mx effect)	ST (Similarity)	ST x SP (Mx effect)
Total carbon												
FF	0.362	0.989	0.336	0.246	0.498	0.107	**0.03**	0.919	0.956	0.609	0.275	0.317
Min1	0.631	0.579	**0.005**	**<0.001**	0.058	**0.008**	0.491	0.233	0.480	0.118	0.32	0.446
Min2	0.5	0.973	**0.007**	0.708	**0.023**	0.44	0.898	0.541	0.546	0.604	0.242	0.895
Total nitrogen												
FF	0.456	0.418	**0.006**	0.106	0.065	0.175	0.85	0.1	0.626	0.245	0.225	0.08
Min1	0.015	0.477	**0.002**	**0.002**	**0.043**	**0.009**	0.653	0.283	0.655	0.072	0.191	0.304
Min2	0.441	0.36	**0.009**	0.818	**0.035**	0.195	0.936	0.22	0.497	0.56	0.284	0.91
C:N ratio												
FF	0.598	0.147	0.193	0.396	0.473	0.218	0.145	0.89	0.659	0.747	0.643	0.215
Min1	0.461	0.093	**0.003**	0.396	**0.043**	0.848	0.626	0.837	0.9	0.884	0.203	0.582
Min2	0.435	0.164	**0.007**	0.255	**0.026**	0.466	0.764	0.212	0.737	0.393	0.173	0.9
Ammonium												
FF	0.256	0.167	0.005	0.533	**0.038**	0.89	0.7	0.63	0.968	**0.017**	0.064	**0.001**
Min1	0.58	0.529	**0.01**	**0.03**	0.091	0.11	0.557	0.929	0.481	**0.048**	0.213	**0.014**
Min2	0.19	0.277	**0.003**	**0.036**	**0.026**	0.06	0.657	0.141	0.791	0.384	**0.023**	0.334
Phosphorus												
FF	0.643	0.186	**0.034**	0.407	0.213	0.65	0.302	**0.041**	0.982	0.97	0.246	0.528
Min1	0.547	0.13	**0.017**	**0.049**	0.186	0.476	0.327	**0.027**	0.836	0.797	0.282	0.68
Min2	0.423	0.703	**0.013**	0.423	0.075	0.097	0.605	0.855	0.85	0.724	0.195	0.433
pH (H_2O)												
FF	0.6	0.194	0.467	0.819	0.534	0.454	**0.013**	0.374	0.907	0.714	0.674	0.241
Min1	0.775	0.775	0.235	0.984	0.54	0.428	0.07	0.691	0.686	0.218	0.512	**0.016**
Min2	0.459	0.134	0.078	0.562	0.218	0.945	0.266	0.653	0.519	0.064	0.472	**0.006**
Potassium												
FF	0.626	0.192	**0.014**	0.818	0.115	0.312	0.294	0.4	0.793	0.98	0.231	0.336
Min1	0.144	0.846	**<0.001**	0.12	**0.025**	0.167	0.608	0.543	0.917	**0.041**	**0.037**	0.058
Min2	0.056	0.852	**<0.001**	0.41	**0.01**	0.804	0.32	0.872	0.956	0.367	**0.02**	0.186
CEC												
FF	0.731	0.865	0.168	0.895	0.238	0.675	0.113	0.185	0.731	0.857	0.255	0.374
Min1	0.453	0.868	**0.002**	**0.003**	**0.046**	0.192	0.715	0.463	0.645	0.081	0.142	0.14
Min2	0.34	0.683	**0.011**	0.858	**0.08**	0.584	0.831	0.742	0.878	0.586	0.09	0.9
Organic layer depth	0.642	0.654	0.174	0.881	0.453	0.98	0.337	0.277	0.926	0.145	0.196	0.92

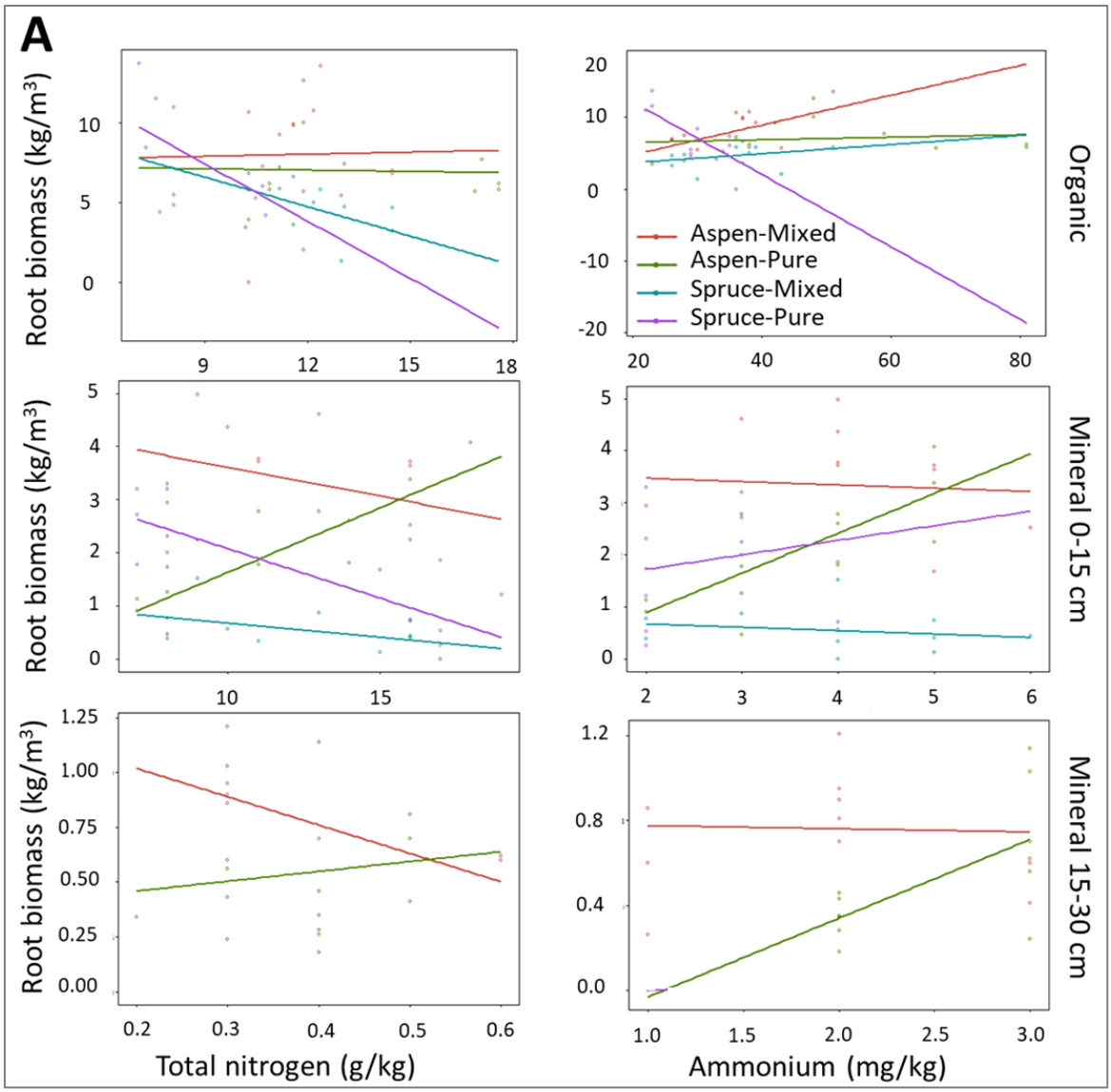

Figure S1. ANCOVA results comparing the variation in (A) fine root biomass (kg m^{-3}) and (B) root dry matter content (g g^{-1}) of black spruce and trembling aspen with soil C:N ratio, total N, ammonium, exchangeable phosphorus and potassium and the sum of exchangeable cations (CEC) concentration within the three soil horizon layers for both species among the three types stands. Each line represent the relationship between the two variables for each species per each stand type (Aspen-Mixed, Aspen-Pure, Spruce-Mixed and Spruce-Pure). For each species, the lines with the same direction indicate the same root allocation strategy between pure and mixed stands whereas lines with opposite directions indicate different strategies. The stronger the correlation between a given nutrient and FRB, the more competitive the species is in one type of stand compared to the other.

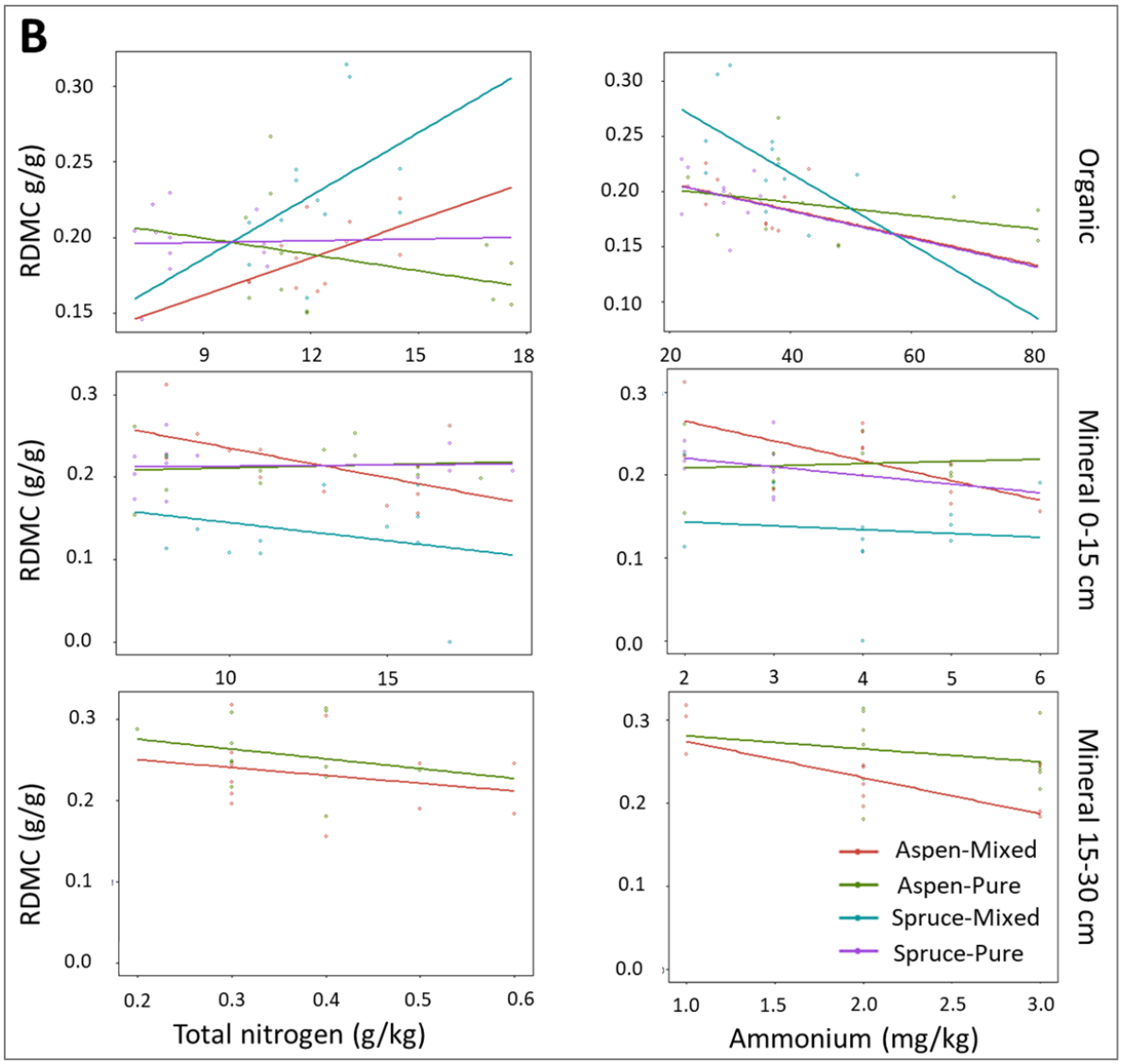

Figure S1. (continued)

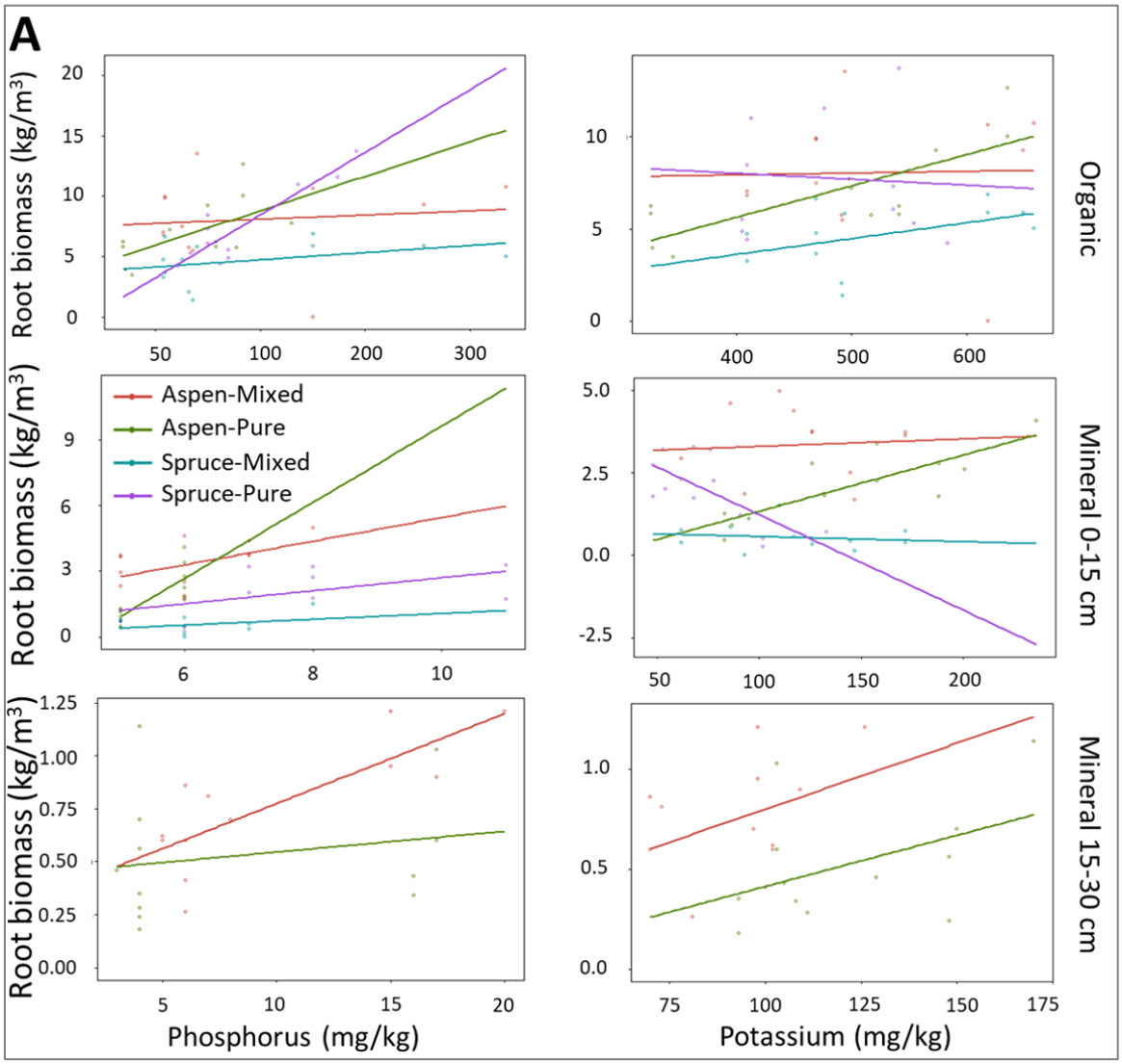

Figure S1. (continued)

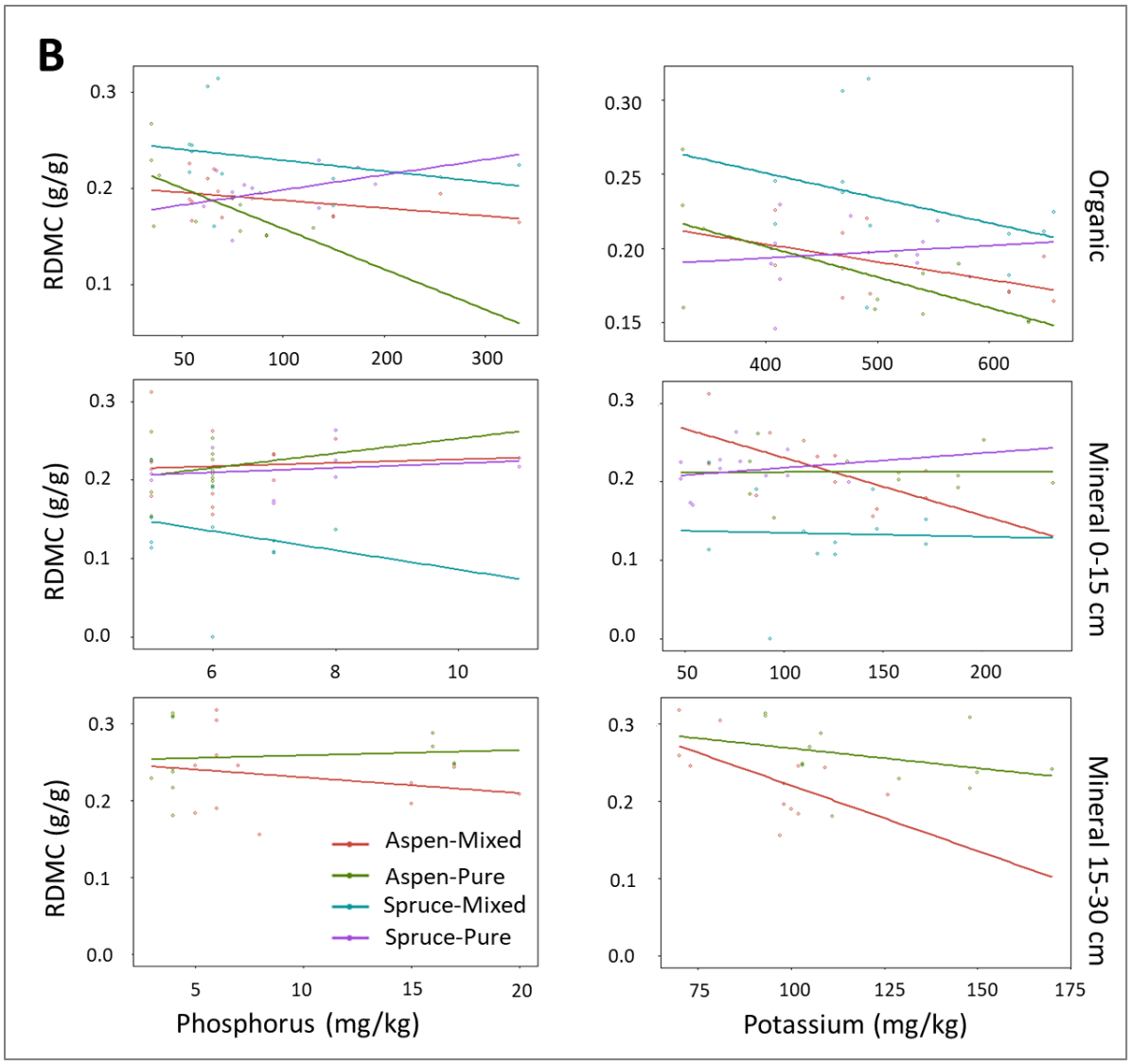

Figure S1. (continued)

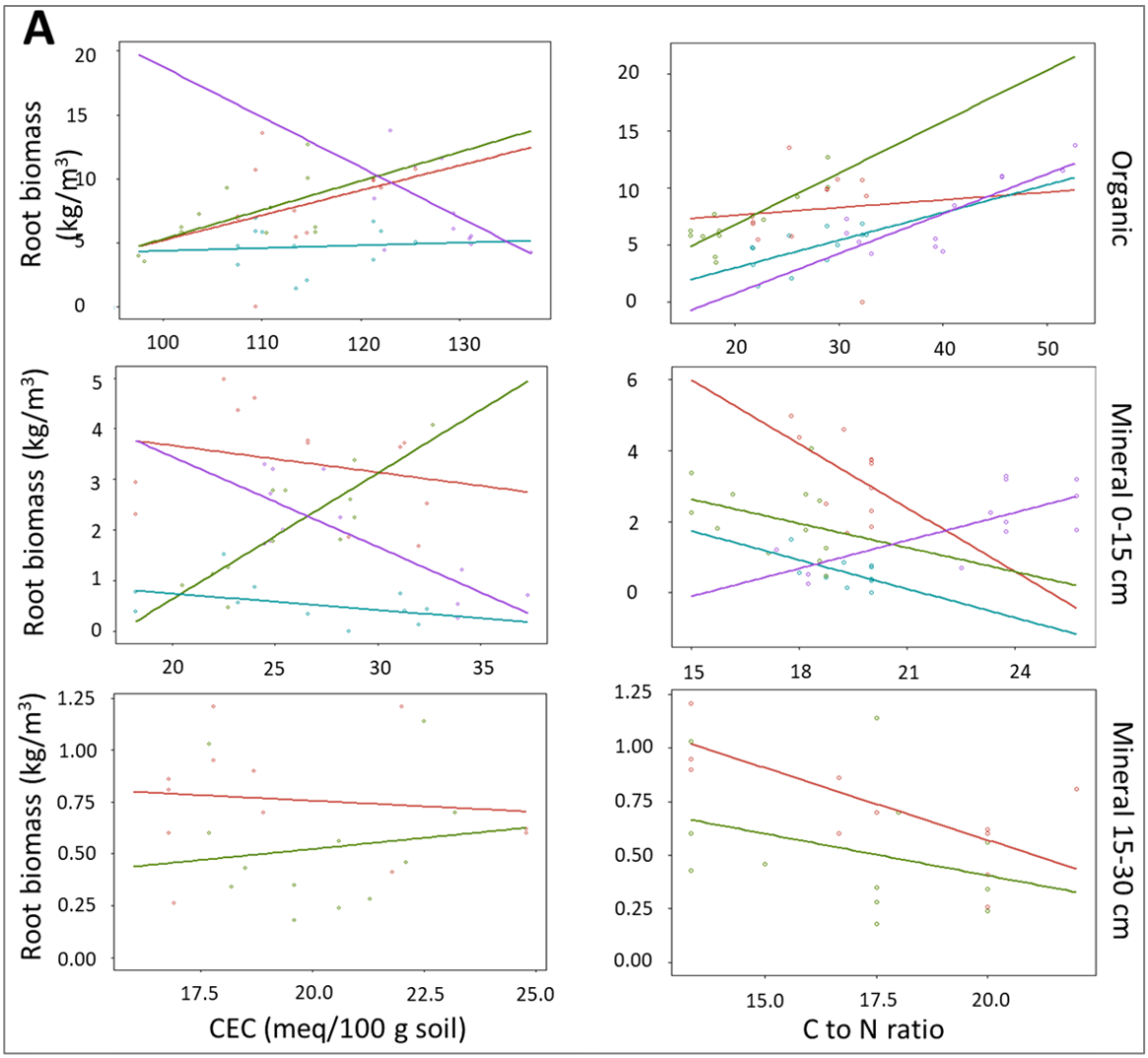

Figure S1. (continued)

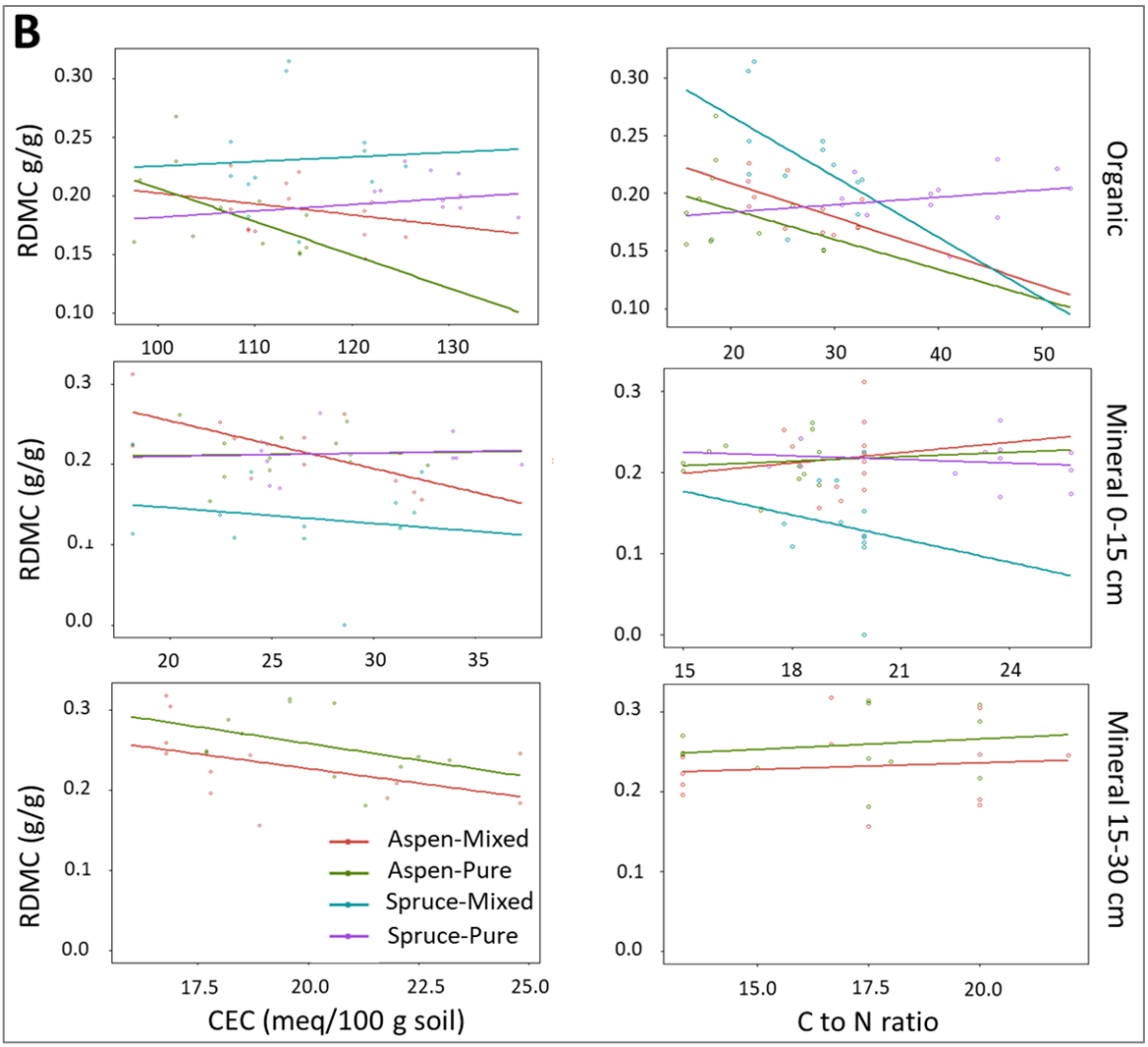

Figure S1. (continued)