

## Empirical modeling of the impact of Mollisol soils variation on performance of Cuphea: a potential oilseed crop

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**Table S1.** Reduced major axes statistics for five nutrient ratios and test of significance between the intercepts [ $p(\alpha)$ ] and the slopes [ $p(\beta)$ ] in soils and seed of Cuphea.

Nutrient ratio	In soils		$R^2$	In seed		$R^2$	$p$	
	Intercept	Slope		Intercept	Slope		$\alpha$	$\beta$
	$\alpha$	$\beta$	$\alpha$	$\beta$				
C:N	-0.29	-0.99	0.57	0.14	0.51	0.35	0.01	0.01
C:P	0.64	-1.46	0.27	0.22	-0.82	0.21	0.01	0.05
N:P	-0.68	1.43	0.49	-0.42	1.63	0.25	0.07	0.12
N:S	-0.34	0.67	0.41	-0.19	1.29	0.19	0.09	0.05
P:S	0.24	0.47	0.77	0.14	0.79	0.69	0.11	0.05

**Table S2.** Basic statistics (mean and standard deviation, SD), level of significance of fixed factors [year, soil series and their interaction,  $p(F)$ ] and percent variance and its significance [ $p(z)$ ] accounted for by random factors (grids within soil series, and year x grids within soil series) in Cuphea performance (seed weight, seed yield, oil content and oil yield) produced on four Mollisols.

Dependent variable	Mean (SD)	Fixed factors			Random factors			
		Year	Soil series	Year x Soil	Grid (Soil)		Year x Grid(Soil)	
					$p(F)$	$p(z)$	% variance	$p(z)$
Seed weight (g)	3.0 (0.12)	0.008	0.442	0.99	0.37	5.6	0.52	5.2
Yield (kg ha <sup>-1</sup> )	344 (172)	0.001	0.002	0.01	0.11	21.7	0.05	84.3
Oil content (%)	29.7 (2.5)	0.001	0.171	0.05	0.13	19.5	0.06	49.5
Oil yield (L ha <sup>-1</sup> )	69.6 (35.2)	0.001	0.004	0.02	0.06	27.6	0.05	73.2

**Table S3.** Basic statistics (mean and standard deviation, SD), level of significance of fixed factors [year and soil series,  $p(F)$ ] and percent variance and its significance [ $p(z)$ ] accounted for by random factors (year x soil and year x grids within soil series) in Cuphea performance (seed weight, seed yield, oil content and oil yield) produced on four Mollisols.

Dependent variable	Mean (SD)	Fixed factors			Random factors		
		Year	Soil	Year x Soil	Year x Grid(Soil)		
					$p(F)$	$p(z)$	% variance
Seed weight (g)	3.0 (0.12)	0.652	0.98	0.01	76.9	0.56	0.25
Yield (kg ha <sup>-1</sup> )	344 (172)	0.002	0.31	0.12	21.0	0.05	82.0
Oil content (%)	29.7 (2.5)	0.001	0.62	0.24	13.7	0.09	37.3
Oil yield (L ha <sup>-1</sup> )	69.6 (35.2)	0.003	0.32	0.21	18.3	0.05	82.4

**Table S4.** Basic statistics (mean and standard deviation, SD) of nutrient ratios in seed as covariates (C:N, C:P, N:P, N:S and P:S), level of significance of fixed factors [year and soil series,  $p(F)$ ] and percent variance and its significance [ $p(z)$ ] accounted for by random factors (grid with soil series and year x soil series) in Cuphea performance (seed weight, seed yield, oil content and oil yield) produced on four Mollisols.

Dependent variable	Covariates (nutrient ratios in seed)					Fixed factors			Random factors		
	C:N	C:P	N:P	N:S	P:S	Year	Soil	Grid(Soil)	Year x soil		
Mean	17.0	12.2	7.1	12.2	1.2						
SD	0.37	1.1	0.63	1.4	0.01						
	$p(F)$							$p(z)$	variance	$p(z)$	variance
Seed wt	0.83	0.38	0.48	0.36	0.15	0.04	0.41	0.29	10.2	0.00	0.00
Seed yield	0.008	0.001	0.001	0.58	0.01	0.005	0.49	0.31	12.3	0.17	33.4
Oil (%)	0.001	0.001	0.04	0.05	0.002	0.001	0.42	0.22	15.7	0.25	15.4
Oil yield	0.02	0.001	0.001	0.69	0.05	0.007	0.47	0.29	9.8	0.18	29.5

**Table S5.** Level of significance of fixed factors [year, soil and their interaction,  $p(F)$ ] and percent variance and its significance [ $p(z)$ ] accounted for by random factors [grid within soil series and year x grid within soil series] in five nutrient ratios in Cuphea seed produced on four Mollisols.

Dependent variable	Fixed factor			Random factors			
	Year	Soil	Year x Soil	Grid(soil)	Year x Grid(soil)		
Seed				$p(z)$	variance	$p(z)$	variance
C:N	0.001	0.68	0.001	0.001	72.1	0.98	3.2
C:P	0.001	0.08	0.22	0.12	20.7	0.14	28.1
N:P	0.001	0.07	0.09	0.28	10.3	0.87	4.5
N:S	0.001	0.001	0.03	0.36	6.3	0.15	23.7
P:S	0.001	0.001	0.05	0.05	25.9	0.02	43.5

**Table S6.** The effects of covariates (soil water, NH<sub>4</sub>, NO<sub>3</sub>, ECe, ECa, and pH), level of significance of fixed factors [year and soil series,  $p(F)$ ] and percent variance and its significance [ $p(z)$ ] accounted for by random factors (grid within soil series and year x soil series) in five nutrient ratios in Cuphea seed produced on four Mollisols.

Dependent variable	Covariates (in soil)						Fixed factors			Random factors		
	Soil water	NO <sub>4</sub> <sup>+</sup>	NO <sub>3</sub> <sup>-</sup>	ECe	ECa	pH	Year	Soil	Grid(soil)	Year x Soil		
									$p(z)$	Variance	$P(z)$	Variance
C:N	0.62	0.04	0.19	0.94	0.93	0.33	0.02	0.28	0.00	0.0	0.0	0.0
C:P	0.001	0.001	0.001	0.02	0.006	0.75	0.03	0.84	0.00	0.0	0.29	11.9
N:P	0.007	0.005	0.006	0.09	0.009	0.58	0.06	0.89	0.29	8.1	0.23	21.3
N:S	0.17	0.001	0.001	0.07	0.03	0.02	0.006	0.27	0.36	6.2	0.49	2.1
P:S	0.12	0.05	0.002	0.05	0.002	0.03	0.005	0.11	0.21	10.6	0.15	9.7

**Table S7.** The effects of five nutrient ratios as covariates in four soil series (C:N, C:P, N:P, N:S and P:S), level of significance of fixed factors [year and soil series,  $p(F)$ ] and percent variance and its significance [ $p(z)$ ] accounted for by random factors (grid within soil series and year x soil series) in five nutrient ratios in Cuphea seed produced on the four Mollisols.

Dependent variable	Covariates (nutrient ratios in soil)					Fixed factors			Random factors		
	C:N	C:P	N:P	N:S	P:S	Year	Soil	Grid(Soil)	Year x soil		
Seed								$p(z)$	variance	$p(z)$	variance
C:N	0.47	0.79	0.11	0.14	0.25	0.26	0.73	0.89	0.0	0.15	50.5
C:P	0.11	0.83	0.58	0.003	0.07	0.008	0.52	0.78	0.0	0.23	21.5
N:P	0.16	0.98	0.98	0.008	0.11	0.009	0.54	0.55	0.0	0.21	20.4
N:S	0.005	0.002	0.005	0.33	0.04	0.008	0.28	0.37	5.6	0.27	21.4
P:S	0.09	0.07	0.05	0.003	0.001	0.002	0.19	0.42	3.4	0.65	9.7