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Supplementary Material

Multivariate assumptions and effect of model parameters in path analysis in oat crop

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Supplementary Table S1. Shapiro-Wilk (SW) univariate normality test p-value and Bartlett (B) univariate homoscedasticity test of variances (B) for 7 variables, from 22 white oat cultivars in five years (2015, 2016, 2017, 2018, and 2019), for original data. Without transformation (B and SW) and with transformation (Bt and SWt) of data, of variables that did not fit in the adherence tests, using the Box-Cox methodology and the respective λ value used.

Years		Variables						
		Yield	PL	PDM	PSN	PGN	GDM	HI
2015	B	0.6968	0.00000000002	0.00000022310	0.00000000024	0.0000136	0.0000004	0.0003
	SW	0.1862	0.00000000003	0.00000064010	0.00000008192	0.0000030	0.0000250	0.0146
	Bt	–	0.00000000023	0.00000001474	0.00000000084	0.0000347	0.0000007	0.0007
	SWt	–	0.00000000004	0.00000165000	0.00000057310	0.0000656	0.0001276	0.0107
	λ	–	1.5200	0.5000	0.5000	0.3200	0.3000	2.2500
2016	B	0.9637	0.7730	0.1673	0.4278	0.5807	0.2416	0.0093
	SW	0.2232	0.2315	0.0862	0.2111	0.0310	0.1894	0.0042
	Bt	–	–	–	–	0.9370	–	0.3433
	SWt	–	–	–	–	0.4247	–	0.1148
	λ	–	–	–	–	-0.4200	–	8.1500
2017	B	1.0000	0.6836	0.8752	0.4949	0.9626	0.9028	0.0343
	SW	0.0003	0.0287	0.8819	0.2334	0.2427	0.4950	0.0000
	Bt	1.0000	0.3956	–	–	–	–	0.8545
	SWt	0.0001	0.0882	–	–	–	–	0.0983
	λ	0.2500	2.5000	–	–	–	–	6.2000
2018	B	0.0099	0.0038	0.5485	0.0373	0.3578	0.4797	0.1114
	SW	0.0197	0.0005	0.1511	0.4781	0.3735	0.3372	0.1810
	Bt	0.1930	0.0039	–	0.0752	–	–	–
	SWt	0.1170	0.0004	–	0.6006	–	–	–
	λ	0.4700	1.1500	–	0.1500	–	–	–
2019	B	0.0855	0.0025	0.2223	0.3910	0.8434	0.1250	0.1022
	SW	0.0008	0.0000	0.1602	0.5190	0.5231	0.1399	0.0002
	Bt	0.8217	0.0078	–	–	–	–	0.3803
	SWt	0.0133	0.0019	–	–	–	–	0.1156
	λ	1.1700	-0.4500	–	–	–	–	4.2000

Yield; PL: panicle length; PDM: panicle dry mass; PSN: panicle spikelet number; PGN: panicle grain number; GDM: panicle grain dry mass; and HI: harvest index.

Supplementary Table S2. Diagnosis of multicollinearity, based on the variance inflation factor (VIF) and condition number (CN), and diagnosis of multivariate normality, using the Shapiro-Wilk test modified by Royston, for the oat yield components, considering the original data from five years (2015, 2016, 2017, 2018, and 2019), data transformation and exclusion of variables to meet the assumptions.

Statistics	Variables						
	Yield	PL	PDM	PSN	PGN	GDM	HI
				2015			
VIF	2.1873	1.1743	480.079	2.7202	3.3897	578.009	16.4623
CN				4467.852			
Shapiro-Wilk				0.0000			
				2016			
VIF	1.433	1.3479	1113.25	4.6444	6.5444	6.5444	1205.05
CN				9426.906			
Shapiro-Wilk				0.0000			
				2017			
VIF	1.7348	1.2697	384.862	2.39778	3.4635	469.147	18.464
CN				3388.211			
Shapiro-Wilk				0.0000			
				2018			
VIF	1.7614	1.2459	512.164	3.4139	4.1872	587.614	14.1485
CN				4045.003			
Shapiro-Wilk				0.0000			
				2019			
VIF	1.5557	1.3288	744.883	3.9402	4.4292	814.614	18.4659
CN				6189.635			
Shapiro-Wilk				0.0000			
	––––––––––––––Transformed data––––––––––––––						
				2015			
VIF	2.1873	1.1743	480.079	2.7202	3.3897	578.009	16.4623
CN				4467.852			
Shapiro-Wilk				0.0000			
				2016			
VIF	1.4329	1.3479	1113.25	4.6444	6.5444	1205.05	19.0268
CN				9426.906			
Shapiro-Wilk				0.0000			
				2017			
VIF	1.7448	1.2697	384.862	2.3978	3.4634	469.147	18.464
CN				3388.211			
Shapiro-Wilk				0.0000			

				2018			
VIF	1.7614	1.2459	512.164	3.4139	4.1872	587.614	14.1485
CN				4045.003			
Shapiro-Wilk				0.0000			
				2019			
VIF	1.5557	1.3288	744.883	3.9402	4.4292	814.614	18.4659
CN				6189.635			
Shapiro-Wilk				0.0000			
			——————————Variable elimination——————————				
				2015			
VIF	2.1804	1.1536	−	2.7163	3.3888	3.2965	2.2336
CN				18.3585			
Shapiro-Wilk				0.0000			
				2016			
VIF	1.4316	1.3395	−	4.6412	6.5208	3.5315	1.2716
CN				33.564			
Shapiro-Wilk				0.0000			
				2017			
VIF	1.7187	1.2526	−	2.39	3.4089	3.136	2.0588
CN				15.6728			
Shapiro-Wilk				0.0000			
				2018			
VIF	1.7311	1.2069	−	3.3951	4.1764	2.2595	1.9725
CN				19.9597			
Shapiro-Wilk				0.0000			
				2019			
VIF	1.5198	1.3263	−	3.9399	4.3947	2.5447	1.3945
CN				23.3466			
Shapiro-Wilk				0.0000			

Yield; PL: panicle length; PDM: panicle dry mass; PSN: panicle spikelet number; PGN: panicle grain number; GDM: panicle grain dry mass; and HI: harvest index.

Supplementary Table S3. Diagnosis of multicollinearity, based on the variance inflation factor (VIF) and condition number (CN), and diagnosis of multivariate normality, using the Shapiro-Wilk test modified by Royston, for the oat yield components, considering the predicted data from five years (2015, 2016, 2017, 2018, and 2019), with the exclusion of variables to meet the assumptions.

Statistics	Variables						
	Yield	PL	PDM	PSN	PGN	GDM	HI
				2015			
VIF	1.1104	1.0133	244.261	2.1068	2.1175	253.066	8.9986
CN				1346.755			
Shapiro-Wilk				0.0000			
				2016			
VIF	1.5609	1.3799	1313.41	5.2035	7.7337	1441.33	24.1068
CN				11618.97			
Shapiro-Wilk				0.0003			
				2017			
VIF	1.8688	1.2539	485.751	2.5454	3.8773	608.955	25.2638
CN				4470.507			
Shapiro-Wilk				0.0000			
				2018			
VIF	1.959	1.2886	666.677	3.6986	4.5494	777.199	18.4365
CN				5409.635			
Shapiro-Wilk				0.0000			
				2019			
VIF	1.7342	1.3999	907.908	4.2447	4.8462	1000.11	22.9544
CN				7802.556			
Shapiro-Wilk				0.0000			
	——————————Variable elimination——————————						
				2015			
VIF	1.1104	1.0074	−	2.0885	2.1166	1.3525	1.1439
CN				7.0499			
Shapiro-Wilk				0.0000			
				2016			
VIF	1.5607	1.3625	−	5.1924	7.6784	3.8165	1.3111
CN				41.1201			
Shapiro-Wilk				0.0000			
				2017			
VIF	1.8536	1.2514	−	2.5415	3.8101	3.5568	2.2764
CN				17.9893			
Shapiro-Wilk				0.0000			

				2018			
VIF	1.9289	1.2648	−	3.6943	4.5492	2.479	2.2476
CN				22.465			
Shapiro-Wilk				0.0000			
				2019			
VIF	1.6494	1.3997	−	4.2433	4.8104	2.8159	1.4402
CN				26.4658			
Shapiro-Wilk				0.0000			

Yield; PL: panicle length; PDM: panicle dry mass; PSN: panicle spikelet number; PGN: panicle grain number; GDM: panicle grain dry mass; and HI: harvest index.