

## Supplementary Informations

**Table S1.** Raw data for the lengths (cm) of radicle root, lateral seminal roots and coleoptile of maize seedlings treated with different concentrations of lignins isolated from CAR.

CAR					
Lignin Concentration (ppm)	Radicle Root	Lignin Concentration (ppm)	Lateral Seminal Roots	Lignin Concentration (ppm)	Coleoptile
0 (control)	6.173	0 (control)	5.088	0 (control)	2.034
	8.166		6.636		3.705
	1.1		5.212		3.279
	7.105		2.803		1.779
	1.201		6.043		5.199
	7.956		5.716		3.436
	6.081		8.588		2.695
	11.787		8.89		4.12
	11.7		9.384		6.442
	7		4.281		5.45
	12.1		4.552		3.741
	6.601		10.429		5.335
	8.735		4.84		3.531
	11.964		10.407		4.796
	8.019		9.274		5.279
	6.109		5.111		4.425
	4.764		5.958		2.567
	4.78		5.146		2.433
	0.9		4.437		3.218
	1.036		3.025		2.702
6.767	6.254	2.29			
5.599	1.32	3.951			
3.213	4.094	2.599			
6.585	3.66	2.557			
0.1	1.989	0.1	9.943	0.1	5.989
	6.835		8.962		3.281
	9.159		7.048		4.619
	4.402		10.685		6.922
	5.481		7.64		7.801
	6.057		7.372		7.727
	6.451		8.104		7.334
	5.717		9.697		6.993
	6.157		8.753		5.647
	4.753		9.603		6.068
	8.998		7.829		6.786
	6.697		7.055		7.512
	8.499		8.754		7.258
	5.15		5.705		5.147
	5.714		5.034		5.624
	4.452		1.84		4.834
	4.449		2.915		2.15
	1.798		3.299		4.293
	1.501		2.992		3.339
	4.774		2.809		4.159
1.662	6.07	4.028			
9	4.096	3.721			
1.66	3.687	4.328			
1	7.53	1	12.35	1	6.29
	7.58		3.95		5.937
	7.34		6.92		6.233
	10.91		10.74		6.184
	5.63		6.64		5.49

	12.01		7.14	6.12
	11.65		11.31	6.213
	4.27		3.66	6.569
	5.81		5.47	7.267
	6.34		5.7	7.245
	1.1		6.27	5.193
	5.38		5.85	4.055
	6.43		9.41	3.122
	5.13		6.78	4.408
	4.56		5.88	4.495
	6.64		8.24	3.941
	8.32		4.22	5.384
	7.4		6.81	4.011
	6.92		11.93	6.127
	1.09		6.62	2.573
	6.01		4.23	2.391
	5.91		7.27	4.833
	0.99		2.87	6.093
	5.58		3.11	5.883
	6.59		3.23	5.838
	0.5		3.66	6.213
	6.33		5.19	6.304
	6.07		5.35	3.567
	0.39		5.44	2.126
	0.8		6.47	7.016
	6.7		6.9	4.535
	6.89		6.91	5.95
	7.78	10	7.26	7.074
	12.001		8.49	6.313
	8.68		9.24	5.679
10	8.82		12.27	3.474
	7.59		12.43	9.116
	12.411		12.93	8.968
	12.001		13.21	4.575
	6.7		13.24	3.893
	8.01		13.29	6.288
	8.61		7.02	6.549
	5.35		4.67	6.818
	6.31		3.46	8.46
	11.84		6.96	7.537
	6.09		5.39	6.944
	6.27		1.1	5.076
	4.95		4.94	6.872
	3.97		3.59	7.957
	0.746		6.2	7.402
	5.2		8.96	7.645
	4.64		6.62	7.6
	1.242		3.63	4.598
	0.717	100	5.19	6.984
	8.5		5.22	5.411
	5.11		3.85	5.995
	4.89		4.28	6.739
100	0.654		10.03	5.218
	1.302		6.95	3.217
	5.01		5.44	3.381
	3.94		5.08	3.853
	4.31		4.74	3.341
	5.51		4.9	4.456
	9.146		6.43	4.242
	6.28		7.64	4.457
	4.7		11.06	4.468
	9.056			3.929

6.3	3.66
8.56	4.749
4.31	4.284
9.003	6.224
4.17	3.575
	4.939
	5.354
	6.401
	4.808
	4.381
	4.329

**Table S2.** Raw data for the lengths (cm) of radicle root, lateral seminal roots and coleoptile of maize seedlings treated with different concentrations of lignins isolated from EUC.

EUC					
Lignin concentration (ppm)	Radicle root	Lignin concentration (ppm)	Lateral Seminal Roots	Lignin concentration (ppm)	Coleoptile
	7.4		14.2		7.44
	7.75		16.05		8.14
	8.85		18.98		8.36
	9.16		21.01		7.31
	9.43		21.74		8.68
	9.89		23.15		8.89
	10.97		23.26		7.41
	11.69		24.48		9.12
	7.11		6.34		9.31
	7.73		8.62		7.68
	9.49		11.34		7.79
0 (control)	9.85	0 (control)	14.3		8.13
	10.1		22.52	0 (control)	8.32
	11.14		23.5		8.56
	12.73		24.79		8.98
	11.02		16.79		8.98
	11.32		19.83		8.31
	11.46		20.49		8.34
	12.65		21.08		8.34
	12.86		21.68		8.47
	13.58		22.43		8.48
	13.8		23.97		8.9
	14.51		25.29		9.46
	14.77		28.94		9.52
	8.03		14.25		9.54
	8.94		16.19		9.56
0.1	9.57	0.1	18.79		8.27
	10.38		18.88		8.41
	11.67		19.44	0.1	8.58
	11.75		20.07		8.91
	11.87		20.46		9.15
	12.28		21.23		9.18
	12.62		24.59		9.33
	6.61		16.13		9.43
	9.52		16.44		7.45
	9.52		17.02		7.81
1	9.54	1	17.37		8.58
	11.95		18.59	1	9.03
	12		18.69		9.15
	12.17		20.28		9.3
	13.8		24.68		9.55
	6.61		5.58		9.89
10	6.85	10	10.75	10	8.73
					8.69

	8.75		11.13		2.51
	9.26		11.47		9.28
	9.26		16.97		9.48
	9.76		17.39		9.29
	9.94		18.5		8.81
	11.91		23.87		8.85
	13.42		28.54		7.64
	8.1		14.45		9.48
	8.59		14.76		6.88
	9.19		20.94		7.48
	9.32		21.21		7.78
	9.62		22.23		7.92
	9.66		23.91		8.16
	11.62		24.83		8.66
	13.62		25.33		8.67
	9.15		21.23		7.9
	15.07		22.88		7.91
	6.99		6.34		8.33
	11.97		22.5		8.38
100	6.97	100	22.07	100	8.4
	10.6		26.22		8.83
	13.61		24.02		8.92
	11.4		23.97		9.33
	12.99		27.24		9.4
	11.31		28.82		7.71
	12.47		22.51		7.76
	13.87		16.42		7.86
	11.98		19.29		8.22
	9.17		20.89		8.32
	6.49		9.04		8.37
	7.34		26.03		8.49
	9.86		11.03		9.21
	11.3		21.6		9.22

**Table S3.** Raw data for the lengths (cm) of radicle root, lateral seminal roots and coleoptile of maize seedlings treated with different concentrations of lignins isolated from RIP.

RIP					
Lignin concentration (ppm)	Radicle root	Lignin concentration (ppm)	Lateral Seminal Roots	Lignin concentration (ppm)	Coleoptile
	6.339		2.126		2.077
	3.191		2.25		2.228
	4.742		2.85		2.484
	7.134		3.129		2.676
	6.917		4.454		2.976
	3.752		5.282		3.605
	2.439		5.419		4.52
	6.267		6.005		4.815
	6.165		6.044		4.854
	4.913		6.084		4.982
0 (control)	3.693	0 (control)	6.566	0 (control)	5.238
	3.717		6.959		5.294
	2.919		7.028		5.459
	2.767		8.076		5.601
	4.938		8.635		5.61
	5.749		8.971		5.625
	6.379		9.735		5.675
	4.61		9.742		5.714
	5.143		10.101		5.734
	5.483		10.431		5.751
	4.019		10.735		5.927

	3.347		10.823		5.967
	8.583		11.308		6.012
	7.042		11.761		6.024
	7.49		12.051		6.208
	5.872		12.067		6.266
	6.813		12.932		6.543
	9.2		13.577		6.58
	3.193		14.001		6.674
	8.216		4.579		6.776
	8.682		6.6		4.147
	6.688		6.862		4.2
	3.714		7.331		4.526
	9.73		7.814		4.537
	10.535		8.015		4.711
	6.944		8.498		4.718
	6.825		8.611		4.722
	5.093		8.781		4.751
	8.169		8.909		4.958
	6.164		8.967		5.12
	7.957		8.991		5.141
	7.02		9.393		5.156
	7.064		9.627		5.267
	9.19		9.944		5.307
	7.442		9.972		5.417
	3.126	0.1	11.102	0.1	5.419
	6.373		11.297		5.426
	9.237		11.346		5.428
	8.383		11.447		5.517
0.1	6.456		11.519		5.58
	3.373		11.959		5.585
	3.252		12.083		5.745
	6.763		12.365		5.763
	8.459		14.247		5.809
	7.531		14.458		5.888
	7.531		14.681		5.932
	6.601		15.314		5.979
	7.07		15.46		5.979
	8.112		15.658		6.091
	8.382		15.968		6.242
	8.112		18.002		6.468
	3.64		18.879		6.62
	4.875		3.394		4.212
	5.657		3.563		4.39
	4.76		3.799		4.449
	4.865		4.571		4.78
	6.193		5.052		5.001
	6.213		5.429		5.175
	4.948		5.676		5.214
	6.963		6.121		5.262
	5.245		7.272		5.378
	7.204		7.406		5.407
	5.93	1	7.645	1	5.412
	6.024		7.678		5.47
1	6.601		7.884		5.476
	6.359		7.966		5.6
	6.467		8.533		5.697
	3.633		9.011		5.717
	3.731		9.383		5.745
	5.742		9.517		5.83
	6.865		9.583		5.843
	6.084		9.664		5.855
	5.964		10.114		5.859

	4.018		10.654		5.86
	5.081		10.684		5.874
	5.163		11.344		5.898
	4.631		11.758		6.139
	5.01		12.072		6.188
	6.638		3.025		6.225
	7.558		4.289		6.476
	8.096		6.141		3.041
	6.986		6.203		3.21
	5.358		6.427		3.447
	5.781		7.037		3.781
	5.879		7.616		3.878
	6.991		7.829		4.153
	6.717		7.83		4.409
	6.385		7.953		4.493
	7.876		8.234		4.605
	7.008		8.966		4.715
	6.017		9.054		5.007
	5.875	10	9.382		5.122
	6.395		9.693		5.434
	5.912		9.989		5.634
	4.563		10.58		5.64
	5.509		10.599		5.662
	3.654		11.133		5.717
	7.752		11.707	10	5.72
	7.453		11.994		5.789
	5.427		12.785		5.962
	5.196		13.791		5.981
10	6.887		13.966		6.139
	8.604		14.377		6.145
	5.987		15.108		6.222
	6.279		15.344		6.265
	6.109		15.843		6.45
	5.917		4.014		6.651
	3.622		4.416		6.67
	7.786		4.468		6.833
	6.544		5.138		6.923
	7.811		5.475		6.957
	8.377		6.247		7.008
	9		6.494		7.103
	5.47		6.814		7.162
	7.29		6.859		7.228
	8.276		7.402		3.188
	4.359		8.562		3.308
	7.753		8.847		3.672
	5.238		9.811		4.395
	6.335		10.089		4.529
	6.232	100	10.841		4.696
	7.086		10.849		4.781
	5.427		11.541		4.821
	7.266		12.066		4.931
	6.623		12.156		5.25
	10.685		12.366	100	5.335
100	7.03		13.022		5.572
	8.764		13.43		5.733
	9.106		13.841		5.936
	9.408		14.227		6.187
	9.159		14.258		6.403
	3.172		14.38		6.537
	8.945		14.956		6.542
	8.952		16.251		6.572
	7.776		16.402		6.618

6.8	6.638
9.804	6.709
3.376	6.71
4.06	6.771
7.475	6.784
5.464	6.957
8.127	7.023
4.884	7.034
3.575	7.048
3.194	7.054
6.831	7.906
4.312	
8.551	

**Table S4.** Raw data for the lengths (cm) of radicle root, lateral seminal roots and coleoptile of maize seedlings treated with different concentrations of lignins isolated from LIM.

LIM					
Lignin concentration (ppm)	Radicle root	Lignin concentration (ppm)	Lateral Seminal Roots	Lignin concentration (ppm)	Coleoptile
	7.298		2.704		4.426
	5.797		7.818		2.999
	6.554		11.258		2.645
	4.99		6.955		4.664
	5.845		7.232		6.025
	6.302		9.799		5.861
	7.171		7.948		4.569
	6.14		8.518		5.416
	7.738		8.163		4.188
	4.431		6.002		5.276
	6.93		10.963		3.93
	3.619		5.975		6.351
	3.601		8.623		3.415
	6.054		6.092		3.652
	6.413		10.615		4.604
0 (control)	6.819	0 (control)	8.676		5.921
	7.92		10.309	0 (control)	4.877
	7.266		12.952		5.851
	5.818		6.46		4.431
	6.638		6.077		5.56
	6.098		8.224		6.04
	3.41		5.758		5.474
	5.734		11.137		6.417
	9.643		15.789		6.105
	6.613		9.554		6.117
	7.405		9.985		6.393
	7.198		9.674		4.528
	8.682		7.316		7
	7.208		6.284		5.942
	7.737		6.241		4.966
	6.952		9.853		5.135
	3.629		15.321		5.279
	9.695		7.924		5.853
	3.386		10.432		6.102
	4.319		9.419		5.777
	9.065		2.219		5.369
0.1	8.855	0.1	15.054		5.81
	10.072		10.178	0.1	6.196
	6.064		3.929		6.393
	6.49		10.247		6.45
	6.991		14.689		6.362
	3.069		10.504		6.016

	4.164		14.723		4.792
	5.94		7.467		7.216
	6.877		11.326		6.111
	7.366		9.186		6.322
	8.202		10.426		4.543
	5.757		6.139		4.454
	7.283		12.989		6.061
	7.096		6.821		6.175
	5.239		8.161		5.783
	5.803		6.795		5.849
	6.966		6.17		4.597
	4.053		9.205		4.428
	6.876		6.853		5.606
	7.345		9.307		5.975
	6.809		9.094		5.708
	4.421		3.709		4.175
	7.108		6.304		5.355
	5.76		7.637		6.112
	4.974		7.614		5.351
	6.665		12.539		6.066
	8.193		7.521		6.003
	7.472		15.916		4.702
	9.81		4.498		6.2
	7.846		9.416		6.742
	9.028		13.452		5.463
	3.792		5.285		5.32
	5.838		6.964		4.79
	6.234		6.823		3.863
	7.726		8.248		4.261
	4.906		12.451		5.381
	5.035		16.024		6.726
	7.263		9.369		6.786
	9.439		11.071		5.267
	8.499		16.729		4.742
	5.55		4.301		7.005
1	4.662	1	13.678		4.953
	6.39		15.884		5.575
	6.671		10.26		5.431
	9.21		5.932		6.258
	8.271		5.238		5.51
	9.318		8.883		5.751
	8.574		6.073		5.466
	8.91		9.468	1	5.054
	5.018		13.143		5.86
	6.352		10.41		5.709
	9.175		6.825		4.95
	8.241		11.959		4.94
	7.958		16.342		5.922
	7.692		12.88		5.509
	8.581		11.886		4.168
	9.533		14.486		6.179
	5.195		6.08		6.748
	7.366		6.666		5.254
	9.025		6.007		6.066
	6.533		6.751		5.204
10	9.462	10	7.872		5.328
	7.862		9.316		5.136
	4.235		4.242		6.254
	7.632		13.246		5.487
	6.29		11.364		6.281
	8.844		3.687	10	5.632
	5.632		10.271		5.356



	7.186		9.108		5.869
	5.906		9.394		4.608
	4.416		14.322		5.985
	5.894		13.28		4.444
	3.999		4.614		6.445
	3.214		5.427		4.937
	4.019		6.341		4.477
	4.974		11.696		5.084
	5.632		11.101		4.805
	8.568		12.086		6.977
	3.446		8.803		5.853
	5.423		15.886		4.833
	6.473		11.564		4.683
	7.727		6.302		5.295
	5.889		12.957		4.904
	6.005		13.412		4.99
	4.347		6.217		5.297
	7.357		6.507		5.07
	7.678		10.382		5.341
	9.946		14.262		5.605
	9.469		10.414		5.506
	9.507		10.273		5.27
	10.124		12.05		6.002
	9.366		10.146		5.846
	6.35		3.233		4.67
	4.73		11.501		5.095
	10.7		9.005		6.455
	9.152		8.856		6.527
	10.401		10.214		3.877
	7.217		7.816		7.217
	9.631		8.934		5.684
	7.183		4.807		6.033
	7.703		8.236		6.594
	4.626		7.94		5.623
100	9.55	100	2.338		5.781
	8.173		8.674		6.844
	5.755		4.266		5.987
	9.456		11.683		6.358
	4.03		14.05		6.089
	9.126		4.572	100	4.699
	5.585		8.748		7.308
	7.555		5.87		6.877
	7.731		7.175		6.521
	7.762		12.799		5.458
	6.315		3.343		7.134
	7.26		9.426		5.833
	7.637		9.318		6.231
	2.174		8.456		6.038
	4.096		11.869		5.702
	4.537		12.8		5.517
					5.492
					6.66
					3.989
					6.343
					7.488