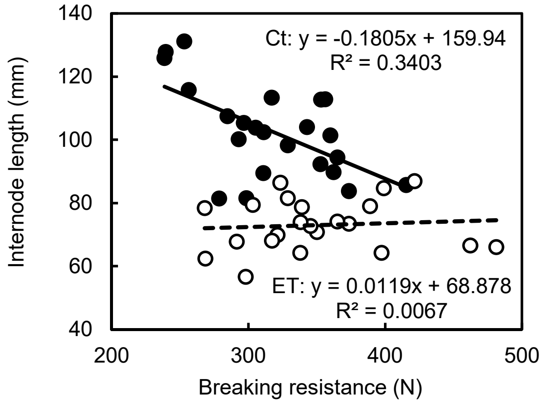
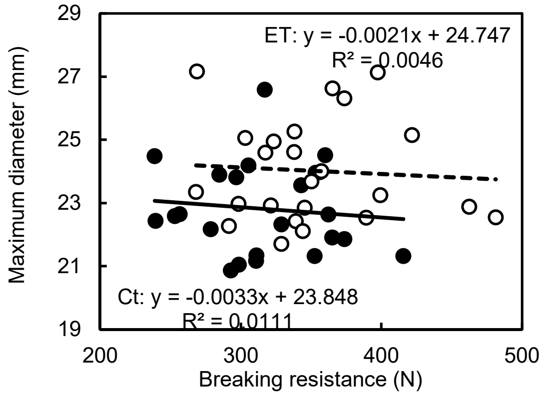
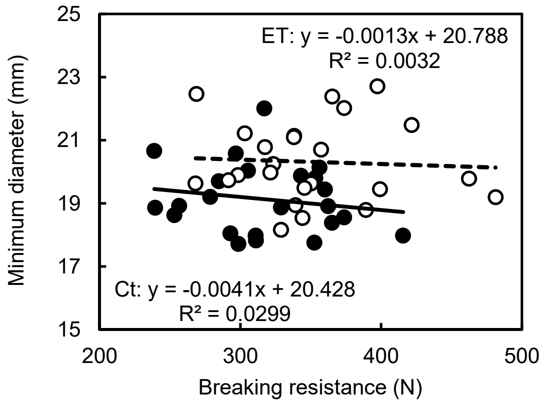


(**a**)



(**b**)



(**c**)

Figure. S1 Pearson's correlation of internode breaking resistance with internode length (a), maximum diameter (b) and minimum diameter (c). Solid round, Ct, control; hollow round, ET, ethephon treatment. Solid line and dash line are regression line of Ct and ET respectively.

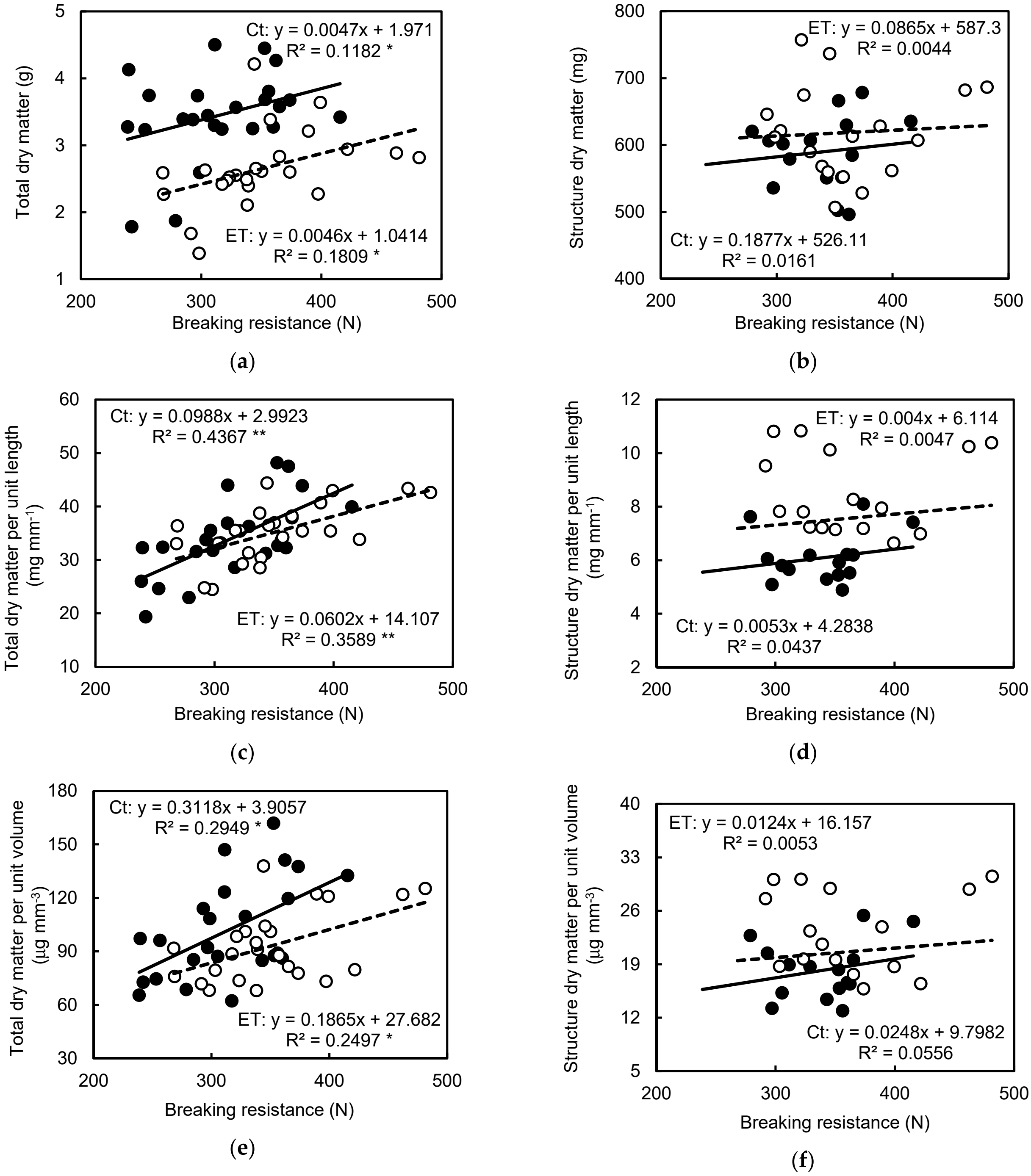


Figure S2. Pearson's correlation of internode breaking resistance with internode dry matter (a), structure dry matter (b), total dry matter per unit length (c), structure dry matter per unit length (d), total dry matter per unit volume (e) and structure dry matter per unit volume (f). Solid round, Ct, control; hollow round, ET, ethephon treatment. Solid line and dash line are regression line of Ct and ET respectively. *, $P < 0.05$, **, $P < 0.01$

Table S1 Rainfall and mean temperature in every ten days during 2013-2017 summer maize growing seasons and 25-year mean in Wuqiao, China.

Weather factors	Date	2013	2014	2015	2016	2017	25-year
Rainfall (mm)	late Jun	0.5	24.9	12.2	52.9	72.3	52.9
	early Jul	86.0	42.1	5.8	56.1	41.6	54.1
	mid-Jul	99.0	48.8	44.4	67.9	23.9	47.0
	late Jul	77.4	38.1	68.0	70.8	61.2	61.9
	early Aug	65.9	8.6	117.2	130.6	36.9	66.1
	mid-Aug	77.0	51.0	0.0	60.9	55.0	39.1
	late Aug	0.0	22.2	58.4	56.8	33.0	25.5
	early Sep	11.8	0.2	34.9	1.3	0.0	20.6
	mid-Sep	0.2	29.3	5.5	1.8	0.0	10.9
	late Sep	29.7	19.0	0.4	0.0	4.8	13.7
	early Oct	0.0	4.3	3.7	0.0	0.0	12.2
	whole season	447.5	288.5	350.5	499.1	328.7	403.9
Tempreture (℃)	late Jun	29.3	25.5	25.2	26.9	26.9	26.4
	early Jul	28.6	27.2	26.6	26.7	29.2	27.2
	mid-Jul	25.0	27.9	27.0	25.7	29.9	26.8
	late Jul	26.9	26.5	27.9	28.9	24.7	27.4
	early Aug	27.7	26.6	27.1	27.2	28.5	26.7
	mid-Aug	28.5	24.2	26.8	26.6	26.0	25.6
	late Aug	25.9	24.9	22.8	24.6	23.7	24.4
	early Sep	22.2	23.0	21.7	24.2	23.6	22.5
	mid-Sep	23.6	18.6	20.1	22.0	23.0	20.9
	late Sep	18.2	19.9	20.8	20.3	21.7	19.2
	early Oct	18.3	15.7	18.0	21.2	17.6	16.7
	whole season	25.0	23.9	24.3	25.1	25.4	24.1

Table S2. Effects of ethephon on the amount per unit volume of total dry matter and structural dry matter in maize internodes

Growing season	Growth stage	Treatment	Total dry matter (μg mm^{-3})		Hemicellulose (μg mm^{-3})		Cellulose (μg mm^{-3})		Lignin (μg mm^{-3})		Structure dry matter (μg mm^{-3})	
2013	V13 [1]	Ct [2]	75.08	b [4]	6.40	b	9.04	b	1.02	a	16.46	b
		ET [3]	85.74	a	7.90	a	10.29	a	1.01	a	19.20	a
	Silking	Ct	88.89	a	6.67	b	10.21	b	1.18	a	18.05	b
		ET	89.61	a	8.20	a	12.37	a	1.04	a	21.61	a
	Grain filling	Ct	119.67	a	6.94	b	11.73	b	1.19	a	19.86	b
		ET	122.15	a	8.40	a	13.90	a	1.58	a	23.88	a
	Harvesting	Ct	121.87	a	6.72	a	10.47	b	1.10	b	18.29	b
		ET	120.87	a	6.38	a	11.10	a	1.19	a	18.67	a
2014	V13	Ct	58.84	b	5.19	b	7.93	b	0.83	a	13.95	b
		ET	55.85	a	6.52	a	9.81	a	0.86	a	17.19	a
	Silking	Ct	84.83	b	5.22	b	8.01	b	1.15	a	14.38	b
		ET	77.73	a	5.64	a	8.84	a	1.30	a	15.77	a
	Grain filling	Ct	87.60	b	5.36	b	8.82	b	1.67	a	15.85	b
		ET	79.73	a	5.56	a	9.37	a	1.52	a	16.45	a
	Harvesting	Ct	92.25	b	4.48	b	7.85	b	0.89	b	13.21	b
		ET	81.57	a	6.26	a	10.08	a	1.31	a	17.66	a
2015	V13	Ct	68.63	a	7.36	b	12.09	b	1.16	a	20.61	b
		ET	68.15	a	10.05	a	17.30	a	1.22	a	28.57	a
	Silking	Ct	147.65	a	8.14	b	13.49	b	1.77	a	23.41	b
		ET	147.76	a	10.27	a	16.02	a	1.91	a	28.19	a
	Grain filling	Ct	132.52	a	7.88	b	14.03	b	2.69	b	24.61	b
		ET	125.28	b	9.87	a	16.89	a	3.76	a	30.52	a
	Harvesting	Ct	123.27	a	9.24	b	14.94	b	3.36	b	27.54	b
		ET	104.23	b	9.51	a	15.53	a	3.88	a	28.92	a
Source of variation												
	Ethephon		*** [5]		***		***		***		***	
	Year		***		***		***		**		***	
	E × Y		ns		***		***		ns		***	

[1] V13, 13-leaf stage; [2] Ct, control; [3] ET, ethephon treatment; [4] Different lower-case letters at the same growth stage in each growing season mean significant difference between Ct and ET by Student's *t*-test at P <0.05; [5] *, **, *** means significant at P <0.05, 0.01 and 0.001, and ns means not significant (P >0.05).

Table S3. Model fitness and quality indices of internode traits and breaking resistance for the proposed hypothetical structural equation model (SEM)

Criteria	Measured Values	p-values and acceptability limits
Average path coefficient (APC)	0.344	p = 0.018
Average R-squared (ARS)	0.833	p <0.001
Average adjusted R-squared (AARS)	0.799	p <0.001
Average block VIF (AVIF)	1.961	acceptable if <= 5, ideally <= 3.3
Average full collinearity VIF (AFVIF)	4.920	acceptable if <= 5, ideally <= 3.3
Tenenhaus GoF (GoF)	0.913	small >= 0.1, medium >= 0.25, large >= 0.36
Sympson's paradox ratio (SPR)	1.000	acceptable if >= 0.7, ideally = 1
R-squared contribution ratio (RSCR)	1.000	acceptable if >= 0.9, ideally = 1
Statistical suppression ratio (SSR)	1.000	acceptable if >= 0.7
Nonlinear bivariate causality direction ratio (NLBCDR)	1.000	acceptable if >= 0.7

Table S4. Model fitness and quality indices of internode mechanical properties for the proposed hypothetical structural equation model (SEM)

Criteria	Measured Values	p-values and acceptability limits
Average path coefficient (APC)	0.327	p = 0.012
Average R-squared (ARS)	0.74	p <0.001
Average adjusted R-squared (AARS)	0.693	p <0.001
Average block VIF (AVIF)	2.526	acceptable if <= 5, ideally <= 3.3
Average full collinearity VIF (AFVIF)	7.848	acceptable if <= 5, ideally <= 3.3
Tenenhaus GoF (GoF)	0.86	small >= 0.1, medium >= 0.25, large >= 0.36
Sympson's paradox ratio (SPR)	0.833	acceptable if >= 0.7, ideally = 1
R-squared contribution ratio (RSCR)	0.972	acceptable if >= 0.9, ideally = 1
Statistical suppression ratio (SSR)	0.917	acceptable if >= 0.7
Nonlinear bivariate causality direction ratio (NLBCDR)	0.958	acceptable if >= 0.7