Table S1. Details of nitrogen application rate and plant density of each experimental site for APSIM-Wheat model calibration in Hubei province.

Region	Cultivar	Experimental year	Nitrogen rate (kg ha^{-1})	Plant density (plant m^{-2})	Sowing date
Wuhan	Zhengmai9023	1999–2000	225	240	10/26/1999
		2008–2009	260	300	10/28/2008
	Emai596	2009–2010	300	150	11/03/2009
	Emai170	2012–2013	195	247.5	10/20/2012
		2015–2016	180	240	11/01/2015
Jingmen	Zhengmai9023	1999–2000	225	240	10/26/1999
		2010–2011	220	300	10/22/2010
	Emai596	2010–2011	220	300	10/22/2010
	Emai18	2008–2009	230	250	10/25/2008
Xiangyang	Zhengmai9023	2001–2002	260	270	10/26/2001
		2010–2011	210	225	10/30/2010
	Emai596	2013–2014	225	230	10/20/2013
	Emai170	2012–2013	230	270	10/28/2012
	Emai18	2007–2008	225	240	10/26/2007

Table S2. Details of nitrogen application rate and plant density of each experimental site for APSIM-Wheat model validation in Hubei province.

Region	Cultivar	Experimental year	Nitrogen rate (kg ha^{-1})	Plant density (plant m^{-2})	Sowing date
Wuhan	Zhengmai9023	2013–2014	322.5	240	10/23/2013
		2014–2015	180	240	10/20/2014
		2015–2016	240	240	11/01/2015
	Emai596	2009–2010	300	150	11/11/2009
		2009–2010	300	225	11/11/2009
		2009–2010	300	300	11/11/2009
		2009–2010	300	150	10/26/2009
		2009–2010	300	225	10/26/2009
		2009–2010	300	300	10/26/2009
		2009–2010	300	225	11/03/2009
	Emai170	2013–2014	195	247.5	10/20/2013
		2015–2016	240	240	11/01/2015
Jingmen	Zhengmai9023	2000–2001	225	240	10/29/2000
		2013–2014	75	270	10/25/2013
		2013–2014	225	270	10/25/2013
	Emai596	2012–2013	238	230	10/26/2012
		2015–2016	200	220	10/28/2015
	Emai170	2015–2016	200	220	10/28/2015
	Emai18	2002–2003	173	240	10/28/2002
		2015–2016	200	220	10/28/2015
Xiangyang	Zhengmai9023	1999–2000	225	240	10/26/1999
		2011–2012	283	260	10/22/2011
		2013–2014	322.5	240	10/23/2013
		2015–2016	0	180	10/26/2015
		2015–2016	180	240	10/26/2015
		2015–2016	240	240	10/26/2015
	Emai596	2013–2014	0	230	10/20/2013
		2013–2014	135	230	10/20/2013
		2013–2014	180	230	10/20/2013
		2013–2014	270	230	10/20/2013
		2015–2016	180	200	10/26/2015
		2015–2016	240	200	10/26/2015
	Emai170	2015–2016	180	200	10/26/2015
		2015–2016	240	200	10/26/2015
	Emai18	2002–2003	120	120	10/21/2002
		2007–2008	0	240	10/26/2007
		2007–2008	150	240	10/26/2007
		2007–2008	270	240	10/26/2007

Table S3. The fitted equation for the linear relationships between the model-simulated and observed growth duration, grain yield and biomass with calibration dataset and reliability measures: coefficient of determination (R^2), normalized root mean square error (NRMSE), refined index of agreement (d_r-value) and percent mean absolute relative error (PMARE).

Growth duration	Linear regression equation	F-value	*p*-value	R^2	NRMSE (%)	d_r-value	PMARE (%)
Sowing to anthesis	y = 0.90x + 16.0	197.1	<0.0001	0.94	0.8	0.83	0.7
Sowing to maturity	y = 0.84x + 33.8	110.0	<0.0001	0.90	1.0	0.82	0.9
Grain yield	y = 0.86x + 1001.3	93.7	<0.0001	0.89	8.6	0.80	5.7
Above ground biomass	y = 0.88x + 1480.8	55.5	<0.0001	0.82	9.4	0.75	7.3

Note: F-value and *p*-value for the fitted lines.

Table S4. The fitted equation for the linear relationships between the model-simulated and observed LAI at jointing and anthesis and reliability measures: coefficient of determination (R^2), normalized root mean square error (NRMSE). Cultivars are Zhengmai9023 and Emai596, data came from field experiment during 2015-2016 and 2016-2017 wheat seasons at Xiangyang and Wuhan.

SLA-max value in the model	Growth stage	Linear regression equation	F-value	*p*-value	R^2	NRMSE (%)
Calibration values in Table 4	Jointing	y = 1.10x – 0.01	44.59	0.0002	0.85	12.5
	Anthesis	y = 0.93x + 0.22	87.81	<0.0001	0.92	6.9
	Whole data	y = 0.96x + 0.11	1113.1	<0.0001	0.98	8.6
Default values	Jointing	y = 0.48x + 0.33	12.48	0.0077	0.61	28.6
	Anthesis	y = 0.43x + 1.45	15.69	0.0042	0.66	31.9
	Whole data	y = 0.37x + 0.28	148.0	<0.0001	0.89	36.5

Note: F-value and *p*-value for the fitted lines.

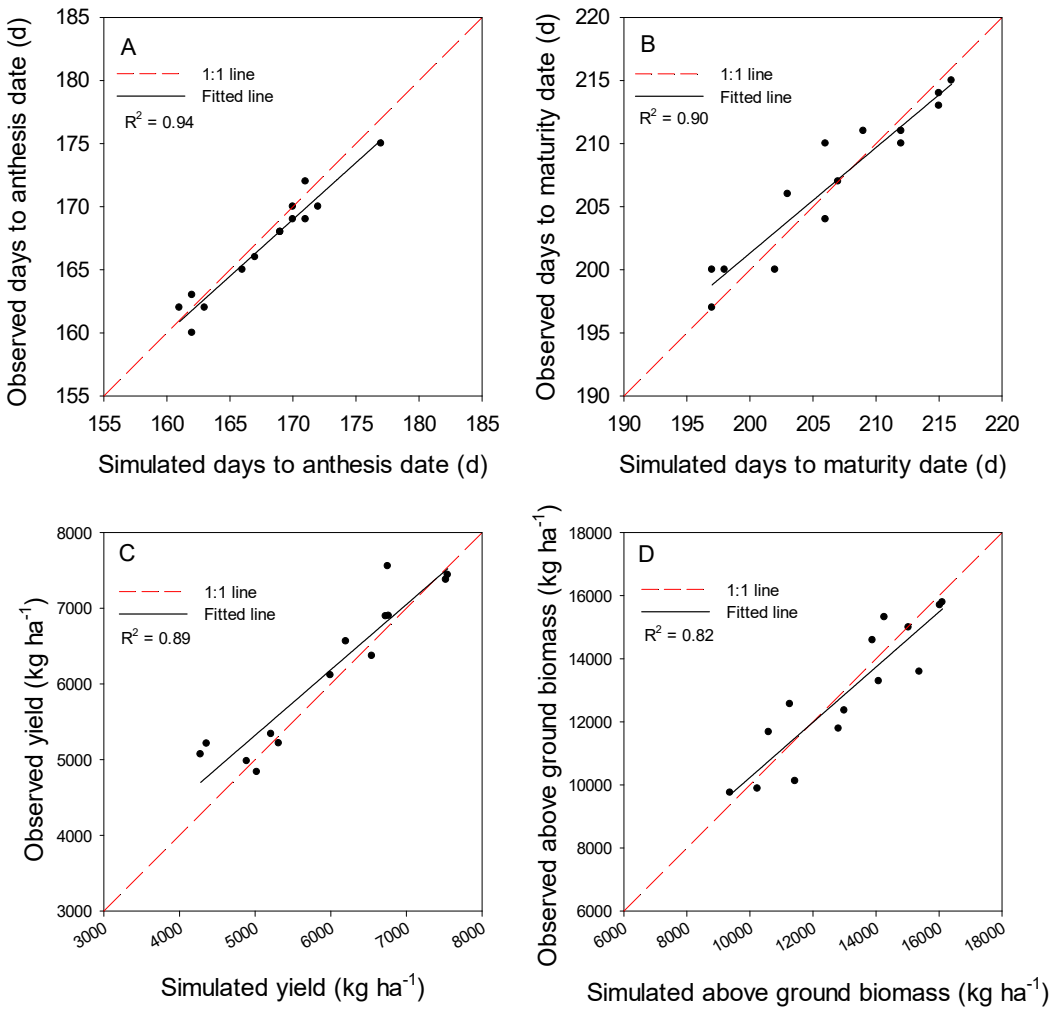

Figure S1. Relationships between the simulated and observed growth duration from sowing to anthesis (**A**) and to maturity (**B**), grain yield (**C**) and above ground biomass (**D**) of winter wheat with calibration dataset in Hubei province. Note: R^2 is presented for the fitted line.

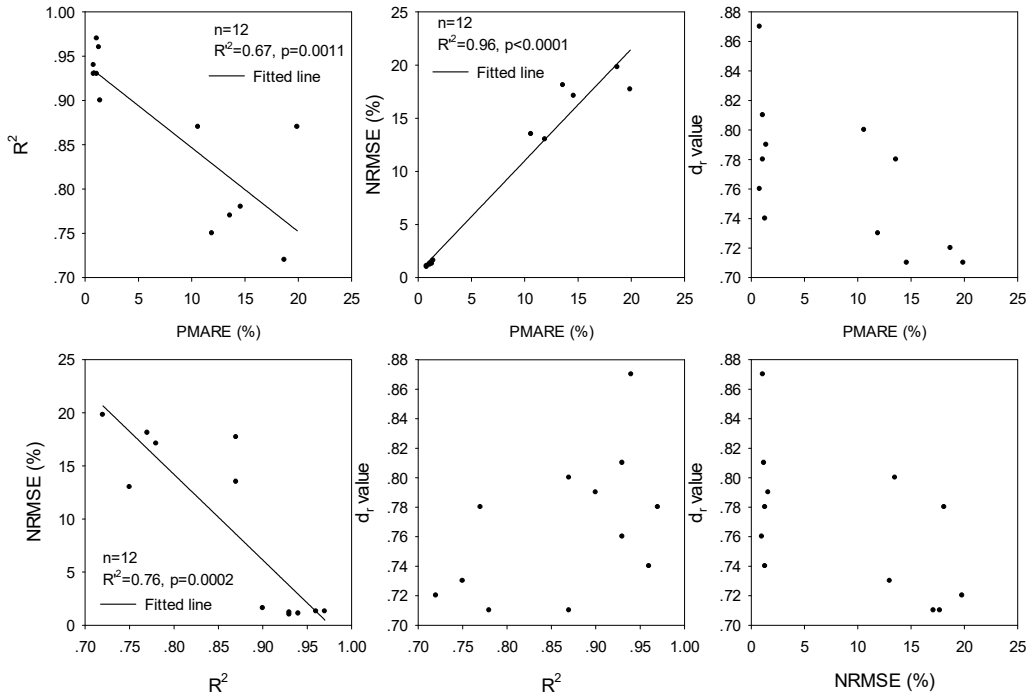

Figure S2. Relationships between indices percent mean absolute relative error (PMARE), determination coefficients (R^2), normalized root-mean-square error (NRMSE), and index of agreement (d_r-value) for all simulations. Note: n means the number of paired data points. Some points overlap, so the actual number of points in some graphs differs from the value of n. R^2 is presented for the fitted line.

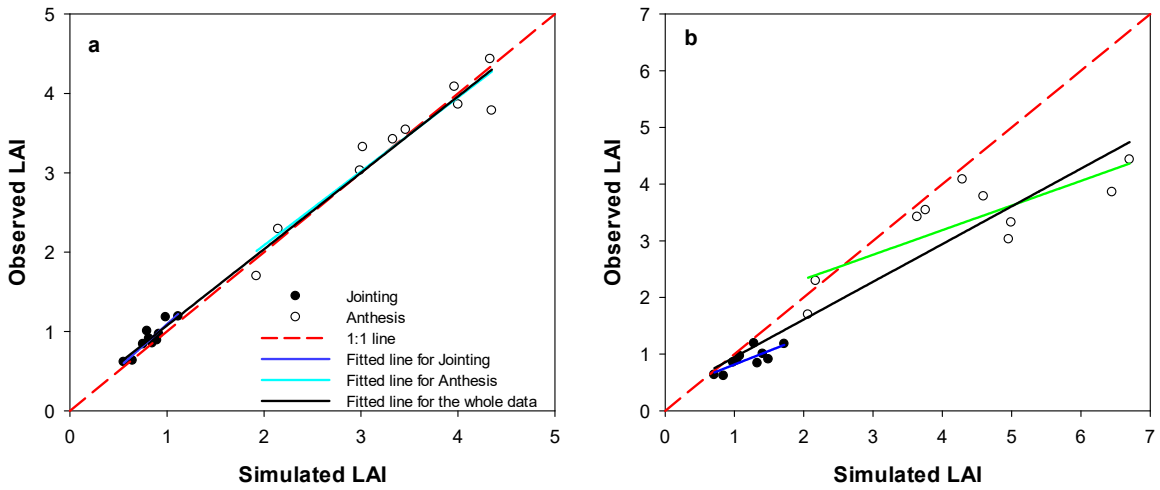

Figure S3. Relationships between simulated and observed LAI at jointing and anthesis with sla-max values from Table 4 (**a**) and default sla-max in the APSIM-wheat model (**b**). Cultivars are Zhengmai9023 and Emai596, data came from field experiment during 2015–2016 and 2016–2017 wheat seasons at Xiangyang and Wuhan.