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Supplementary Data

1. Effects of different oxidation and reduction time on tobacco P700 signal under 20% far-red light

Supplementary Table S1: Effects of low intensity far-red light on tobacco P700 signal at different time of opening and closing

Time/s	20s	40s	60s	80s	100s
20s	0.8522±0.0768	0.9786±0.0104	1.0924±0.1348	0.9767±0.0609	1.0452±0.0115
40s	0.9515±0.0319	0.9856±0.0261	0.9724±0.0836	1.0494±0.0865	1.0488±0.0142
60s	0.8620±0.0128	0.9981±0.0536	0.9601±0.0444	1.0744±0.0811	1.0441±0.0609
80s	0.8679±0.0418	0.9863±0.0784	0.9974±0.0472	1.0073±0.0603	1.0678±0.1345
100s	0.8787±0.0312	0.9973±0.0738	1.0129±0.0329	1.1853±0.2838	1.0916±0.1532

Table 1s Effects of different time periods of low intensity far-red light on tobacco P700 signal. Horizontal indicates that the time to turn on the low intensity (20%) far-red light is 20s，40s，60s，80s，100s; Longitudinal means the time to turn off the weak far-red light is 20s, 40s, 60s, 80s and 100s.Data are means with error bars indicating SD (n = 3); The same below.

2. Effects of different oxidation and reduction time on tobacco P700 signal under 50% far-red light

Supplementary Table S2: Effects of medium intensity far-red light on tobacco P700 signal at different time of opening and closing

Time/s	20s	40s	60s	80s	100s
20s	0.7294±0.0521	---	1.2932±0.0461	1.3800±0.0764	1.3978±0.1438
40s	0.7580±0.1574	---	1.2940±0.0461	1.3204±0.0741	1.3758±0.1475
60s	0.8456±0.0470	---	1.2581±0.0083	1.3935±0.0829	1.4153±0.0389
80s	0.8456±0.0482	---	1.2749±0.0928	1.2738±0.0540	1.3628±0.1239
100s	0.9355±0.2943	---	1.3390±0.1353	---	---

3. Effects of different oxidation and reduction time on tobacco P700 signal under 80% far-red light

Supplementary Table S3: Effects of high intensity far-red light on tobacco P700 signal at different time of opening and closing

Time/s	20s	40s	60s	80s	100s
20s	0.6496±0.0771	1.7146±0.1913	1.8006±0.1138	1.7615±0.3308	1.9383±0.0534
40s	0.8556±0.1284	1.8373±0.3860	1.7760±0.0672	1.7436±0.1544	1.8333±0.0211
60s	0.6671±0.1076	1.6527±0.0973	1.7860±0.1286	1.7706±0.1066	1.6933±0.2407
80s	0.7338±0.0279	1.6758±0.1667	1.5703±0.0822	1.8422±0.1087	---
100s	---	---	1.7066±0.1856	---	---

4. A comprehensive analysis of the test results of tobacco by design-expert

4.1: Relationship model between PGR5-dependent CEF and each variable

Table 4s and 5s show the ANOVA comparison between PGR5 cyclic electron flow and various fitting models with different parameters given by design-expert 8.0.6 Trian, respectively. Table 3 is the confidence analysis of design-expert 8.0.6 Trian on the quadratic polynomial model and various influencing factors in the model.

Supplementary Table S4: Sequential model sum of squares for box-behnken design

Source	Sum of Squares	df	Mean Square	F Value	p-value Prob > F	
Mean vs Total	354.21	1	354.21			
Linear vs Mean	19.89	3	6.63	126.34	<0.0001	
2FI vs Linear	2.58	3	0.86	20.54	<0.0001	
Quadratic vs 2FI	2.68	3	0.89	29.38	<0.0001	Suggested
Cubic vs Quadratic	2.38	9	0.26	12.91	<0.0001	Aliased
Residual	4.39	214	0.020			
Total	386.12	233	1.66			

Supplementary Table S5: Model summary statistics for box-behnken design

Source	Std.Dev.	R-Squared	Adjusted R-Squared	Predicted R-Squared	PRE SS	
Linear	0.23	0.6234	0.6184	0.6076	12.52	
2FI	0.20	0.7041	0.6962	0.6816	10.16	
Quadratic	0.17	0.7879	0.7793	0.7667	7.45	Suggested
Cubic	0.14	0.8625	0.8510	0.8357	5.24	Aliased

5. Quadratic equation model and student-dependent residuals of the relationship between PGR5-dependent CEF and each variable of tobacco

Supplementary Table S6: Quadratic model analysis of confidence degree

Factor	Coefficient estimate	df	Standard error	95% CI Low	95% CI High	VIF
Intercept	1.29	1	0.030	1.24	1.35	
A-open FR time	0.26	1	0.018	0.23	0.30	1.10
B-close FR time	1.369E-003	1	0.018	-0.035	0.037	1.17
C-light intensity	0.29	1	0.014	0.26	0.32	1.10
AB	-6.030E-003	1	0.026	-0.058	0.046	1.11
AC	0.18	1	0.021	0.13	0.22	1.10
BC	-0.022	1	0.021	-0.064	0.020	1.17
A^2	-0.23	1	0.028	-0.29	-0.18	1.05
B^2	0.023	1	0.029	-0.035	0.081	1.11
C^2	0.090	1	0.026	-0.039	0.14	1.03

Equations (1s) and (2s) are quadratic equation models of PGR5 dependent cyclic electron flow and each factor expressed by factor code form and actual factor value form respectively.
Figure 1s shows the student-oriented residual distribution of the fitting model, from which it can be seen that 97% points of the residual are distributed between -2 and 2, almost on a straight line, and the model has a good fitting effect.

Final equation in terms of coded factors:

$CEF=1.29+0.26*A+1.369E-003*B+0.29*C-6.030E-003*AB+0.18*AC-0.022*BC-0.23*A^2+0.023*B^2+0.090*C^2$ **(1s)**

Final equation in terms of Actual factors:

$CEF=+0.57355+0.016740*A-5.42860E-004*B-0.81237*C-3.76860E-006*AB+0.014717*AC-1.83021E-003*BC-1.44382E-004*A^2+1.43193E-005*B^2+1.00331*C^2$ **(2s)**

6. Experiment scheme optimization of tobacco

Table 7s is the optimal scheme to obtain the optimum CEF. According to the optimization results, the best CEF can be obtained when the far-red light is turned on for 100s and the far-red light 20s is turned off, accompanied by 80% light intensity, which is consistent with the optimal results in the experimental data. This result is consistent with the results of the mulberry experiment.

Supplementary Table S7: Optimization scheme of determination of PGR5-dependent cyclic electron flow

Number	Open FR time/(s)	Close FR time/(s)	Light intensity	CEF	Desirability	
1	100	20	80%	1.931	1	Selected
2	100	60	80%	1.882	1	
3	80	20	80%	1.882	1	
4	80	40	80%	1.853	1	
5	80	60	80%	1.836	1	
6	84	50	80%	1.765	1	
7	63	57	80%	1.698	1	
8	60	40	80%	1.690	1	
9	60	100	80%	1.677	1	
10	60	80	80%	1.670	1	

7. The results of the confidence analysis of the quadratic model of mulberry

Supplementary Table S8: Quadratic model analysis of confidence degree

Factor	Coefficient Estimate	df	Standard Error	95% CI Low	95% CI High	VIF
Intercept	1.26	1	0.0 5	1.21	1.31	
A-open FR time	0.34	1	0.022	0.29	0.38	1.01
B-close FR time	-0.029	1	0.022	-0.072	0.014	1.02
C-light intensity	0.36	1	0.021	0.32	0.40	1.01
AB	-0.010	1	0.046	-0.10	0.081	1.00
AC	0.49	1	0.044	0.40	0.57	1.01
BC	-0.025	1	0.043	-0.11	0.060	1.02
A2	-0.52	1	0.055	-0.63	-0.41	1.00
B2	0.020	1	0.055	-0.088	0.13	1.00
C2	0.10	1	0.062	-0.019	0.23	1.01

8. Model summary statistics for box-behnken design of mulberry

Supplementary Table S9: Model summary statistics for box-behnken design

Source	Std. Dev.	R-Squared	Adjusted R-Squared	Predicted R-Squared	PRE SS	
Linear	0.22	0.5218	0.5159	0.5020	12.42	
2FI	0.19	0.6543	0.6457	0.6278	9.28	
Quadratic	0.16	0.7507	0.7413	0.7252	6.85	Suggested
Cubic	0.12	0.8622	0.8514	0.8352	4.11	Aliased

Supplementary Table S10: Sequential model sum of squares for box-behnken design. The ANOVA comparison between the PGR5 cyclic electron flow and various fitting models with different parameters obtained by Design-Expert 8.0.6 Trian

Source	Sum of Squares	df	Mean Square	F Value	p-value Prob > F	
Mean vs Total	329.53	1	329.53			
Linear vs Mean	13.01	3	4.34	89.10	<0.0001	
2FI vs Linear	3.31	3	1.10	30.92	<0.0001	
Quadratic vs 2FI	2.41	3	0.80	30.82	<0.0001	Suggested
Cubic vs Quadratic	2.78	9	0.31	20.68	<0.0001	Aliased
Residual	3.44	230	0.015			
Total	354.47	249	1.42			

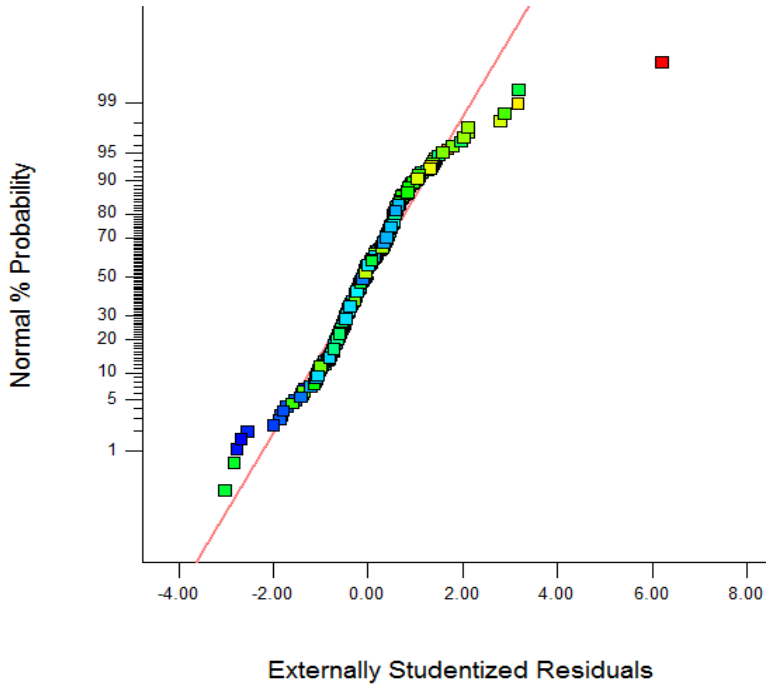
Supplementary Table S11: Optimization scheme of determination of PGR5-dependent cyclic electron flow. the experimental parameters were further optimized by using Design-Expert 8.0.6 Trian. The optimal scheme for the value of each parameter was thus obtained under the condition of the optimum cyclic electron flow

Number	Open FR time/(s)	Close FR time/(s)	Light intensity	CEF	Desirability	
1	97	20	80%	1.74045	0.839	Selected
2	98	20	80%	1.73998	0.838	
3	100	20	80%	1.73900	0.838	
4	93	20	80%	1.73860	0.837	
5	99	23	80%	1.73606	0.836	
6	95	25	80%	1.73403	0.835	
7	89	20	80%	1.73269	0.834	
8	93	27	80%	1.73069	0.832	
9	99	27	80%	1.73020	0.832	
10	95	20	79%	1.72993	0.832	

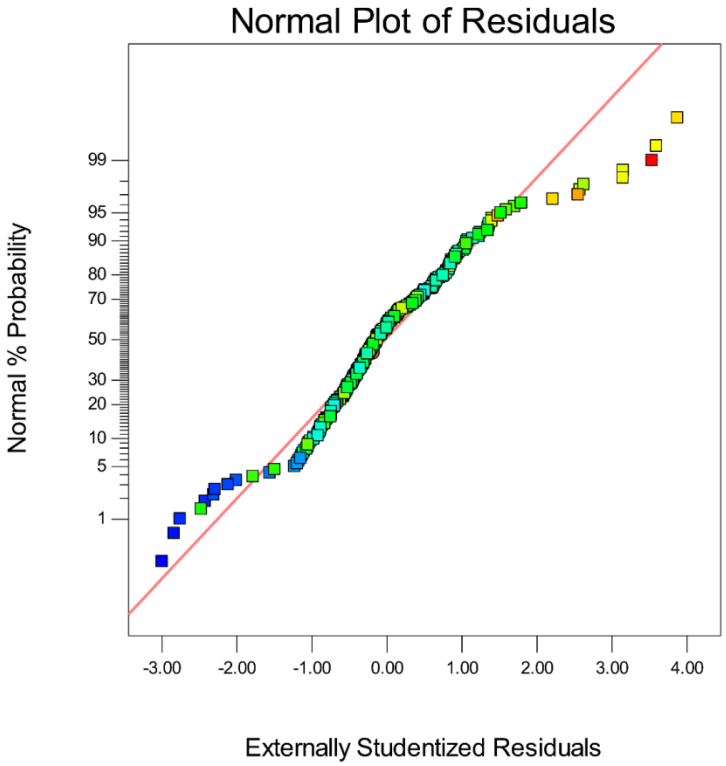
Supplementary Table S12: The ANOVA comparison of significant for equation in terms of coded factors of tobacco and mulberry by SPSS 22.0.

		mulberry	tobacco
Mulberry	Pearson related significant（Double tail）	1	0.952**
			0.000
N		10	10
Tobacco	Pearson related significant（Double tail）	0.952**	1
		10	0.000
N			10

**: The correlation was significant at the 0.01 layer (double-tailed)



Supplementary Fig. S1: Normal probability plot of residual for PGR5 cyclic electron flow



Supplementary Fig. S2: Normal probability plot of residual for PGR5 cyclic electron flow. 97% of the points of the residual are distributed between -2 and 2, and lie almost on a straight line.