Table S1. Ablation study results of Random Forest (RF) model in different phenological stages

Phenological Stage	Parameter	Value	R^2	RMSE	NRMSE
Green-up	n_estimators	50	0.8247	0.0240	0.0944
	max_depth	5	0.8364	0.0232	0.0912
	min_samples_split	15	0.8210	0.0243	0.0954
Budding	n_estimators	500	0.8957	0.0308	0.0780
	max_depth	10	0.8923	0.0313	0.0793
	min_samples_split	10	0.8897	0.0316	0.0803
Early flowering	n_estimators	300	0.8868	0.0412	0.0682
	max_depth	10	0.8855	0.0414	0.0685
	min_samples_split	5	0.8857	0.0414	0.0685
Peak flowering	n_estimators	100	0.9292	0.0424	0.0636
	max_depth	5	0.9297	0.0423	0.0634
	min_samples_split	5	0.9291	0.0424	0.0636
Fruiting	n_estimators	50	0.7701	0.0886	0.1171
	max_depth	20	0.7626	0.0900	0.1190
	min_samples_split	5	0.7629	0.0900	0.1189

Note: Only the optimal results for each parameter are shown. When testing n_estimators, other parameters were set to their default values (max_depth=None, min_samples_split=2). When testing max_depth, other parameters were set to default values (n_estimators=100, min_samples_split=2). When testing min_samples_split, other parameters were set to default values (n_estimators=100, max_depth=None).

Table S2. Ablation study results of Support Vector Regression (SVR) model in different phenological stages

Phenological Stage	Parameter	Value	R^2	RMSE	NRMSE
Green-up	C	1	0.8457	0.0225	0.0886
	gamma	0.1	0.8681	0.0208	0.0819
	epsilon	0.1	0.8457	0.0225	0.0886
Budding	C	5	0.9224	0.0265	0.0673
	gamma	0.1	0.9068	0.0291	0.0738
	epsilon	0.2	0.8750	0.0337	0.0854
Early flowering	C	5	0.9182	0.0350	0.0579
	gamma	0.1	0.9102	0.0366	0.0607
	epsilon	0.01	0.9136	0.0359	0.0595
Peak flowering	C	2	0.9402	0.0390	0.0585
	gamma	0.1	0.9489	0.0360	0.0540
	epsilon	0.01	0.9396	0.0392	0.0587
Fruiting	C	10	0.7943	0.0838	0.1107
	gamma	0.1	0.7677	0.0890	0.1177
	epsilon	0.1	0.7716	0.0883	0.1167

Note: Only the optimal results for each parameter are shown. When testing C, other parameters were set to default values (gamma='scale', epsilon=0.1). When testing gamma, other parameters were set to default values (C=1.0, epsilon=0.1). When testing epsilon, other parameters were set to default values (C=1.0, gamma='scale').

Table S3. Ablation study results of Artificial Neural Network (ANN) model in different phenological stages

Phenological Stage	Parameter	Value	R^2	RMSE	NRMSE
Green-up	dropout	0.1	0.8314	0.0236	0.0926
	dropout	0.2	0.8289	0.0237	0.0933
	dropout	0.3	0.7081	0.0310	0.1218
	dropout	0.4	0.7972	0.0258	0.1016
Budding	dropout	0.1	0.9265	0.0258	0.0655
	dropout	0.2	0.9020	0.0298	0.0756
	dropout	0.3	0.8994	0.0302	0.0766
	dropout	0.4	0.8989	0.0303	0.0768
Early flowering	dropout	0.1	0.9038	0.0379	0.0628
	dropout	0.2	0.9087	0.0370	0.0612
	dropout	0.3	0.8910	0.0404	0.0669
	dropout	0.4	0.8929	0.0400	0.0663
Peak flowering	dropout	0.1	0.9543	0.0341	0.0511
	dropout	0.2	0.9437	0.0378	0.0567
	dropout	0.3	0.9189	0.0454	0.0681
	dropout	0.4	0.9067	0.0487	0.0730
Fruiting	dropout	0.1	0.7184	0.0980	0.1296
	dropout	0.2	0.7739	0.0879	0.1161
	dropout	0.3	0.7133	0.0989	0.1307

Note: When testing dropout, other parameters were set to default values (neurons=128, learning_rate=0.01).