

Figure S1. Comparisons of total carbon and NSCs between needles on DOY 174 (23<sup>th</sup> June, 2021). SS, soluble sugar. 0, current-year needles; 1, one-year needles; L, low light; F, full light. \*\*\*\* $p < 0.001$ , \*\* $p < 0.01$ , \* $p < 0.05$ .

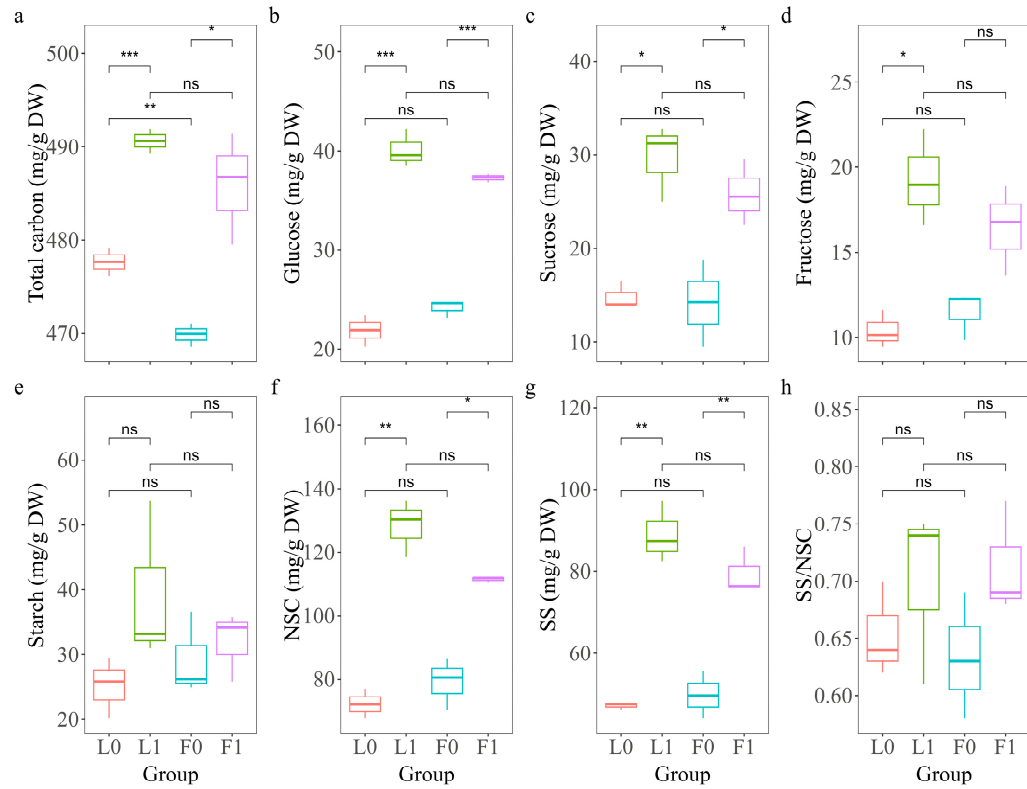


Figure S2. Comparisons of total carbon and NSCs between needles on DOY 210 (29<sup>th</sup> July, 2021). SS, soluble sugar. 0, current-year needles; 1, one-year needles; L, low light; F, full light. \*\*\* $p < 0.001$ , \*\* $p < 0.01$ , \* $p < 0.05$ .

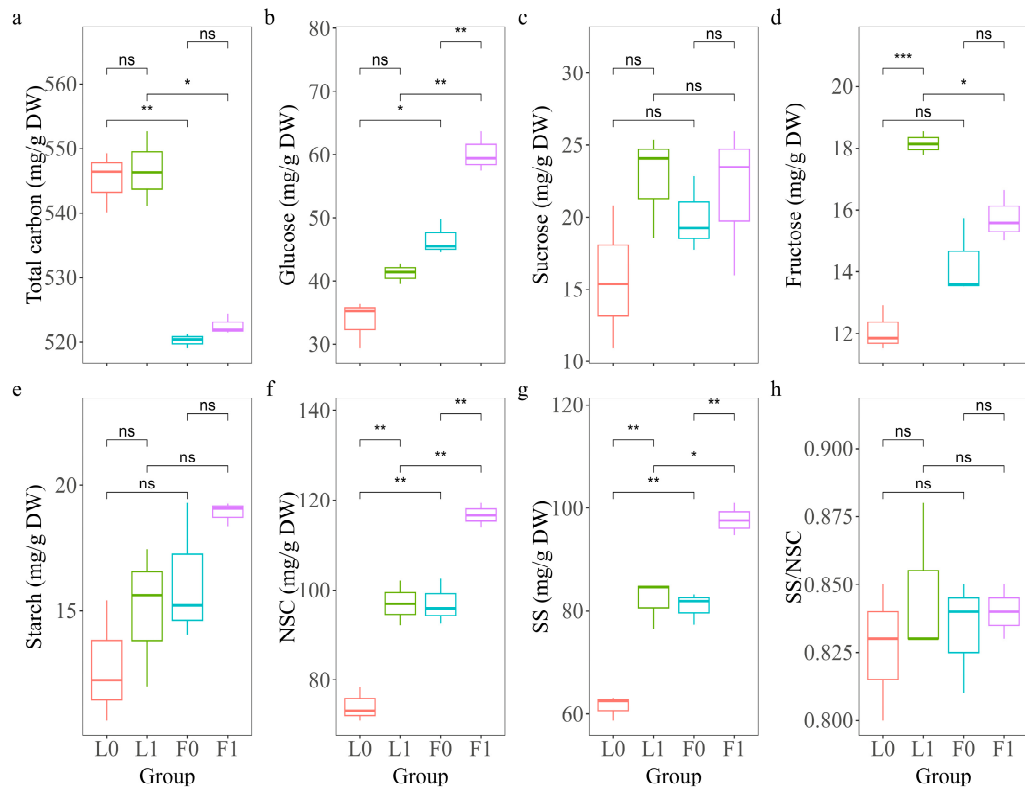


Figure S3. Comparisons of total carbon and NSCs between needles on DOY 249 (6<sup>th</sup> September, 2021). SS, soluble sugar. 0, current-year needles; 1, one-year needles; L, low light; F, full light. \*\*\* $p < 0.001$ , \*\* $p < 0.01$ , \* $p < 0.05$ .

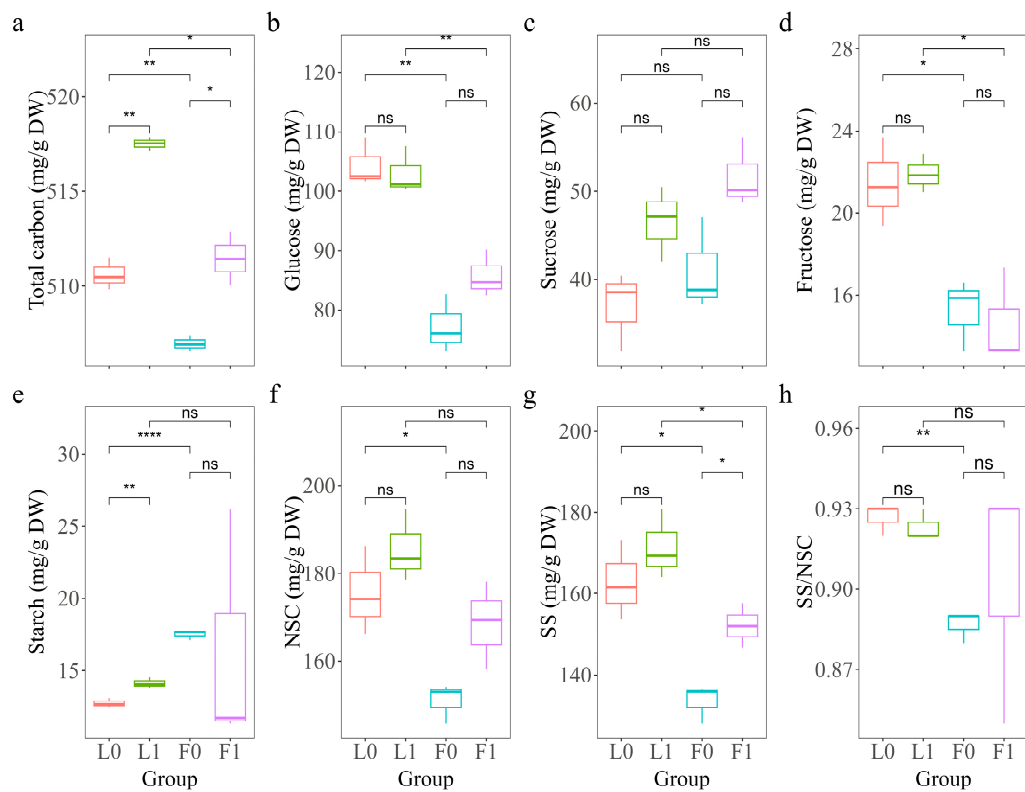


Figure S4. Comparisons of total carbon and NSCs between needles on DOY 298 (25<sup>th</sup> October, 2021). SS, soluble sugar. 0, current-year needles; 1, one-year needles; L, low light; F, full light. \*\*\* $p < 0.001$ , \*\* $p < 0.01$ , \* $p < 0.05$ .

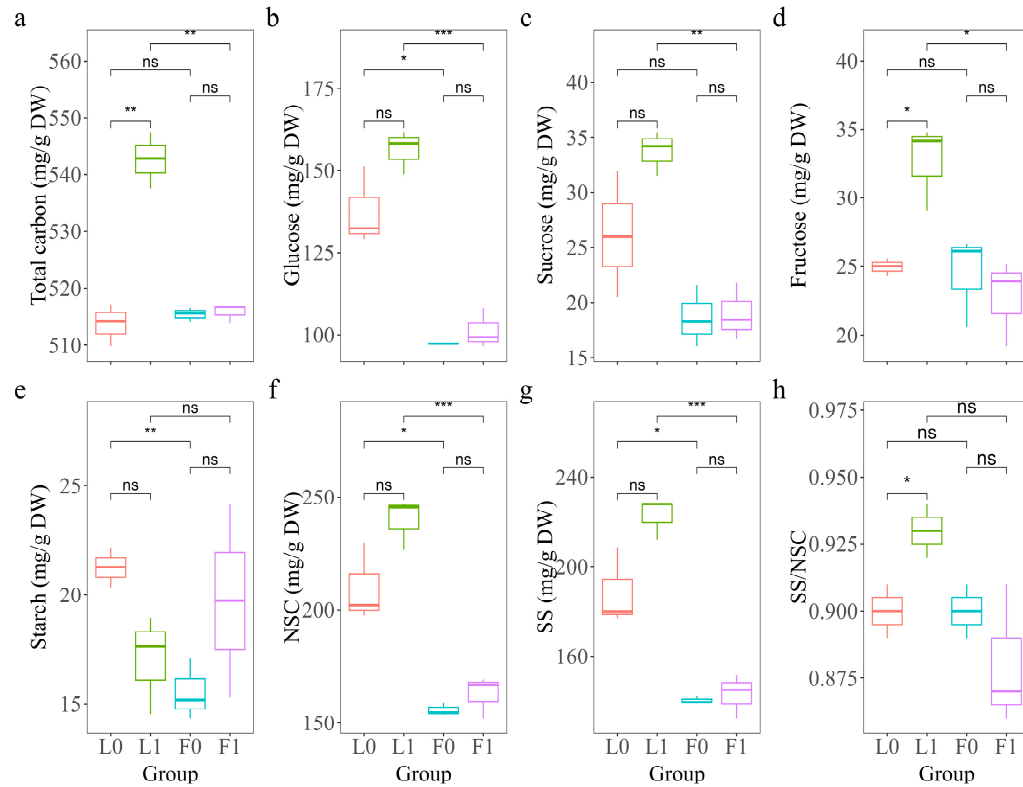


Figure S5. Comparisons of total carbon and NSCs between needles on DOY 335 (1<sup>st</sup> December, 2021). SS, soluble sugar. 0, current-year needles; 1, one-year needles; L, low light; F, full light. \*\*\* $p < 0.001$ , \*\* $p < 0.01$ , \* $p < 0.05$ .

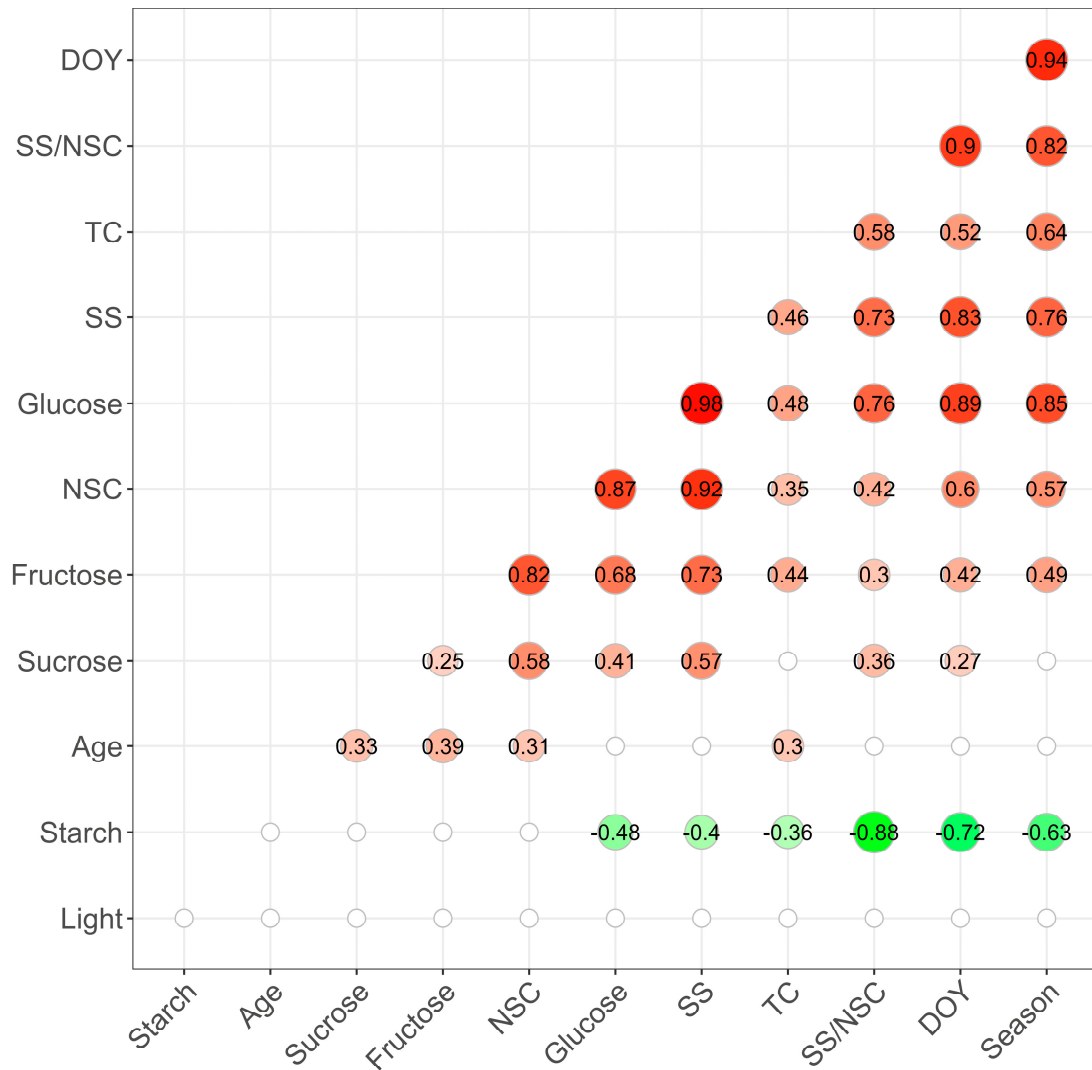


Figure S6. Correlations of all parameters in needles. TC, total carbon concentration. DOY, day of the year. SS, soluble sugar. Non-significant correlations are omitted ( $p < 0.05$ ), negative correlations are in green colour and positive correlations in red, the colour gradient shows the strength of the correlation. There were 3 seasons included in the analysis procedure, summer, autumn and winter.

Table S1. Comparison of the means of total carbon and NSCs of Korean pine needles.

Group	DOY	Total carbon (mg/g DW)	Glucose (mg/g DW)	Sucrose (mg/g DW)	Fructose (mg/g DW)	Starch (mg/g DW)	NSC (mg/g DW)	SS (mg/g DW)	SS/NSC
L0	174	463.00±3.25	18.80±1.39	30.18±3.03	12.93±1.84	37.78±7.26	99.69±6.61	61.91±5.67	0.62±0.06
		d	d	ab	c	a	c	c	c
	210	477.65±1.54	21.86±1.59	14.83±1.45	10.41±1.10	25.11±4.65	72.22±4.62	47.10±0.76	0.65±0.04
		c	d	c	c	b	d	c	c

	249	545.27±4.67	33.64±3.76	15.69±4.95	12.10±0.72	12.76±2.42	74.20±3.85	61.44±2.33	0.83±0.03
		a	c	c	c	c	d	c	b
	298	510.61±0.84	104.41±4.07	36.95±4.51	21.45±2.16	12.75±0.30	175.56±10.11	162.81±9.81	0.93±0.00
		b	b	a	b	c	b	b	a
	335	513.75±3.73	137.58±11.92	26.13±5.71	24.96±0.64	21.26±0.90	209.92±17.52	188.67±17.42	0.90±0.01
		b	a	b	a	b	a	a	a
L1	174	514.31±3.87	36.94±2.62	32.15±2.25	27.70±3.90	60.68±11.30	157.46±11.60	96.78±5.10	0.62±0.05
		b	c	b	b	a	c	c	d
	210	490.60±1.30	40.07±1.92	29.65±4.11	19.28±2.83	39.32±12.50	128.32±9.02	89.00±7.50	0.70±0.08
		c	c	b	c	b	d	c	c
	249	546.71±5.81	41.22±1.65	22.66±3.64	18.16±0.38	15.03±2.77	97.07±4.96	82.04±4.73	0.85±0.03
		a	c	c	c	c	e	c	b
	298	517.51±0.36	102.99±3.95	46.55±4.25	21.91±0.93	14.15±0.36	185.60±8.24	171.44±8.56	0.92±0.01
		b	b	a	c	c	b	b	ab
	335	542.66±4.94	156.26±6.68	33.74±2.03	32.66±3.15	17.05±2.26	239.71±11.35	222.66±9.17	0.93±0.01
		a	a	b	a	c	a	a	a
F0	174	495.69±0.61	25.58±1.74	20.55±1.48	16.22±3.14	66.65±1.54	128.99±3.81	62.35±3.15	0.48±0.01
		d	d	b	b	a	b	c	d
	210	469.86±1.21	24.17±0.88	14.16±4.62	11.48±1.41	29.26±6.42	79.07±8.10	49.81±5.82	0.63±0.06
		e	d	b	c	b	d	c	c
	249	520.23±1.10	46.61±2.78	19.95±2.61	14.29±1.26	16.18±2.75	97.03±5.06	80.85±3.07	0.83±0.02
		a	c	b	bc	c	c	c	b
	298	506.96±0.41	77.28±4.93	41.04±5.29	15.24±1.75	17.52±0.34	151.08±4.51	133.56±4.68	0.88±0.01
		c	b	a	bc	c	a	b	a
	335	515.44±1.19	97.23±0.14	18.63±2.81	24.45±3.35	15.56±1.42	155.86±2.85	140.31±1.48	0.90±0.01
		b	a	b	a	c	a	a	a
F1	174	507.67±1.84	36.80±3.11	25.56±3.63	21.02±0.75	77.49±9.97	160.87±7.28	83.38±2.86	0.52±0.04
		c	d	b	a	a	a	c	c
	210	485.87±5.95	37.27±0.42	25.82±3.51	16.44±2.65	31.92±5.34	111.45±0.79	79.53±5.66	0.71±0.05
		d	d	b	b	b	b	c	b
	249	522.60±1.60	60.21±3.21	21.81±5.20	15.75±0.83	18.90±0.46	116.68±2.70	97.78±3.14	0.84±0.01
		a	c	b	b	c	b	c	a
	298	511.45±1.41	85.80±3.94	51.69±3.92	14.63±2.34	16.44±8.46	168.56±10.01	152.12±5.41	0.90±0.04
		bc	b	a	b	c	a	b	a
	335	515.88±1.71	101.28±6.03	18.98±2.59	22.74±3.15	19.73±4.43	162.73±9.31	143.00±9.81	0.88±0.03
		b	a	b	a	c	a	a	a

The data were the means of three replicates ± SDs. Different letters indicated differences among different sampling times (DOY, day of the year, 2021), all done in Duncan's test,  $p < 0.05$ . 0, current-year needles; 1, one-year needles; L, low light; F, full light.

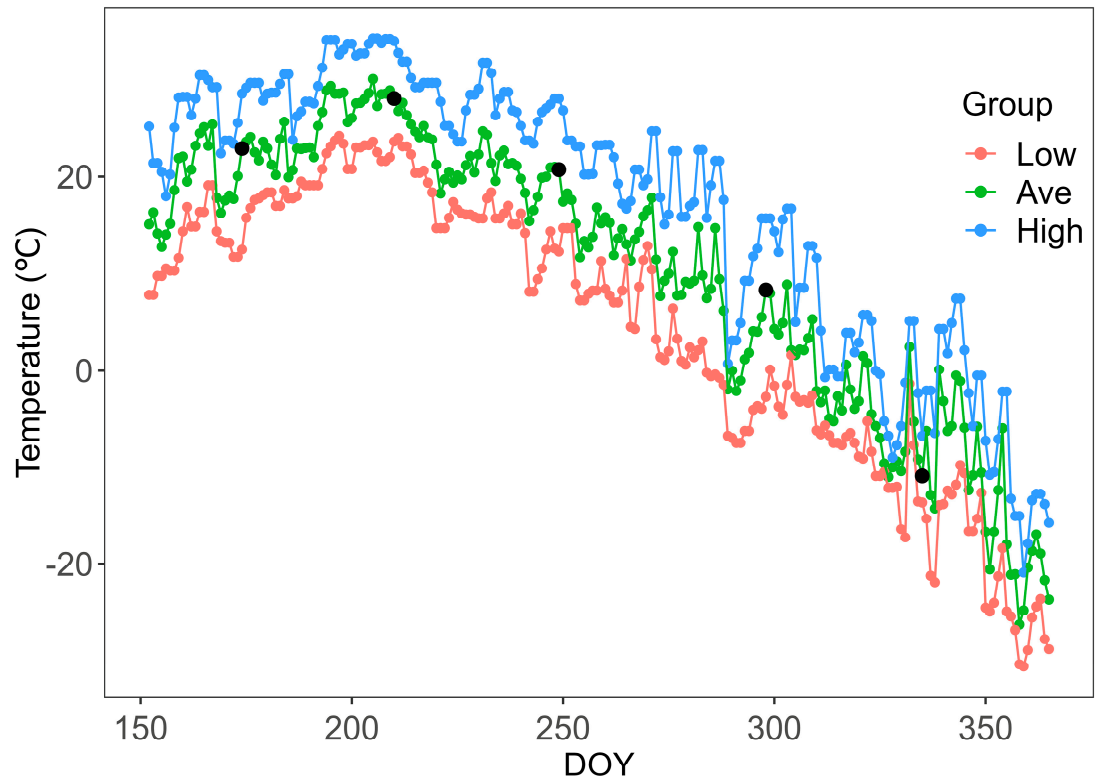


Figure S7. Low, average (Ave), high air temperature in sampling site from June to November. Data from NCEI (National oceanic and atmospheric administration), NOAA (National centers for environmental information). DOY, day of the year, 2021. Expanded black dots represented average temperature on each sampling day.