1 **Table S1**. Soil characteristics of the experimental soybean fields at Tohoku Agricultural Research Center (TARC), National Agriculture and Food Research Organization

2 (NARO), Morioka, Iwate Prefecture, Japan, in 2015 and 2016.

	2015	2016
Soil type	Andosol	
Soil pH	6.4	6.7
Available P (mg kg^{-1})	31	43
Exchangeable K (mg kg^{-1})	124	247
Exchangeable Mg (mg kg^{-1})	823	1441
Exchangeable Ca (mg kg^{-1})	4790	7325
Cation exchange capacity (cmol kg^{-1})	39.5	43.6
Bulk density (g [100 mL]$^{-1}$)	56.6	71.9
θ_{FC} (mm^3 mm^{-3})	0.470	0.585
θ_{WP} (mm^3 mm^{-3})	0.193	0.239

3 θ_{FC}, volumetric soil water content at field capacity (pF = 1.5); θ_{WP}, volumetric soil water content at permanent wilting point (pF = 4.2).

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5 **Table S2.** Aboveground biomass (g m^{-2}), seed yield (g m^{-2}), harvest index (HI), and yield components (numbers of pods per plant, seeds per pod, nodes per

6 plant, and pods per node, and 100-seed weight, g) of three soybean cultivars (Ryuhou, Enrei, Satonohohoemi) with normal and late sowing dates in 2015 and

7 2016 in the Tohoku region of northern Japan.

Year	Cultivar	Sowing date	Aboveground weight (g m^{-2})	Seed yield (g m^{-2})	HI	Number of pods (per plant)	Seeds per pod	Number of nodes (per plant)	Pods per node	100-seed weight (g)
2015	Ryuhou	Normal	444	270	0.61	59.1	1.62	37.5	1.56	31.4
		Late	344	201	0.59	46.5	1.58	32.5	1.42	28.6
	Enrei	Normal	486	257	0.53	53.6	1.57	47.8	1.13	30.6
		Late	368	180	0.49	41.3	1.45	35.3	1.17	26.4
	Satonohohoemi	Normal	599	293	0.49	61.5	1.27	46.8	1.31	35.6
		Late	439	224	0.50	58.8	1.03	39.9	1.48	33.3
2016	Ryuhou	Normal	557	333	0.60	80.7	1.47	48.5	1.66	30.8
		Late	491	289	0.59	73.4	1.38	48.5	1.51	29.4
	Enrei	Normal	549	319	0.58	80.1	1.45	53.7	1.49	30.0
		Late	438	228	0.52	72.6	1.17	45.9	1.58	27.2
	Satonohohoemi	Normal	618	330	0.53	79.3	1.28	55.3	1.43	35.3
		Late	420	162	0.39	75.0	0.60	43.3	1.73	31.9

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10 **Table S3.** Days from emergence (VE) to full flowering (R2), from R2 to the beginning of seed filling (R5), from R5 to the beginning of maturity (R7), and from VE to R7 for three

11 soybean cultivars (Ryuhou, Enrei, Satonohohoemi) with normal and late sowing dates in 2015 and 2016 in the Tohoku region of northern Japan.

Year	Cultivar	Sowing date	Days from VE to R2	Days from R2 to R5	Days from R5 to R7	Days from VE to R7
2015	Ryuhou	Normal	49	18	45	111
		Late	39	17	42	98
	Enrei	Normal	53	22	43	119
		Late	39	20	43	103
	Satonohohoemi	Normal	53	22	53	128
		Late	41	20	52	113
2016	Ryuhou	Normal	51	18	47	116
		Late	41	18	46	105
	Enrei	Normal	54	20	48	122
		Late	43	18	46	107
	Satonohohoemi	Normal	55	21	53	129
		Late	44	18	58	120

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14 **Table S4.** Increase in aboveground biomass (ΔAGB, g m^{-2}), cumulative intercepted irradiation (CumIR, MJ m^{-2}), and radiation use efficiency for dry matter production (RUE, g

15 MJ^{-1}) during reproductive stages (from R2 to R5 and from R5 to 20 days after R5) of three soybean cultivars (Ryuhou, Enrei, Satonohohoemi) with normal and late sowing dates

16 in 2015 and 2016 in the Tohoku region of northern Japan.

| Year	Cultivar	Sowing date	ΔAGW (g m^{-2})		CumIR (MJ m^{-2})		RUE (g MJ^{-1})	
			R2–R5	R5–R5 + 20 d	R2–R5	R5–R5 + 20 d	R2–R5	R5–R5 + 20 d
2015	Ryuhou	Normal	196	238	270	212	0.73	1.13
		Late	163	218	189	204	0.86	1.07
	Enrei	Normal	252	238	341	170	0.74	1.40
		Late	206	214	197	239	1.05	0.89
	Satonohohoemi	Normal	287	173	321	173	0.89	1.00
		Late	196	189	211	218	0.92	0.86
2016	Ryuhou	Normal	222	298	265	306	0.84	0.97
		Late	184	255	217	267	0.85	0.95
	Enrei	Normal	307	241	315	271	0.98	0.89
		Late	199	262	224	248	0.89	1.06
	Satonohohoemi	Normal	320	296	306	272	1.05	1.09
		Late	156	273	206	273	0.75	1.00

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19 **Table S5.** Pearson's coefficients of correlation of the relationships between mean temperature and the FASW (fraction of available soil water) during reproductive stages (from

20 R2 to R5 and from R5 to R5 + 20 days) and seed yield (g m^{-2}), yield components (numbers of pods per plant, seeds per pod, nodes per plant, and pods per node, and 100-seed

21 weight, g), increase in aboveground biomass (ΔAGB, g m^{-2}), cumulative intercepted irradiation (CumIR, MJ m^{-2}), and radiation use efficiency for dry matter production (RUE, g

22 MJ^{-1}) across three soybean cultivars and two sowing dates in 2015 and 2016 (n = 12) in the Tohoku region of northern Japan.

	FASW R2–R5	FASW R5–R5 + 20 days	Seed yield	Number of nodes	Pods per node	Seeds per pod	100-seed weight	ΔAGB	RUE	CumIR
Temperature R2–R5	−0.835	–	0.372	0.379	0.678	0.044	−0.136	−0.088	−0.309	0.027
Significance	***	–	ns	ns	*	ns	ns	ns	ns	ns
Temperature R5–R5 + 20 days	–	−0.873	0.585	0.506	0.527	0.134	−0.229	0.179	0.073	0.120
Significance	–	***	*	ns	ns	ns	ns	ns	ns	ns
FASW R2–R5	–	–	−0.364	−0.098	−0.418	−0.476	0.293	0.175	0.516	−0.093
Significance	–	–	ns	ns	ns	ns	ns	ns	ns	ns
FASW R5–R5 + 20 days	–	–	−0.363	−0.684	−0.596	0.306	0.101	−0.149	−0.158	−0.011
Significance	–	–	ns	*	*	ns	ns	ns	ns	ns

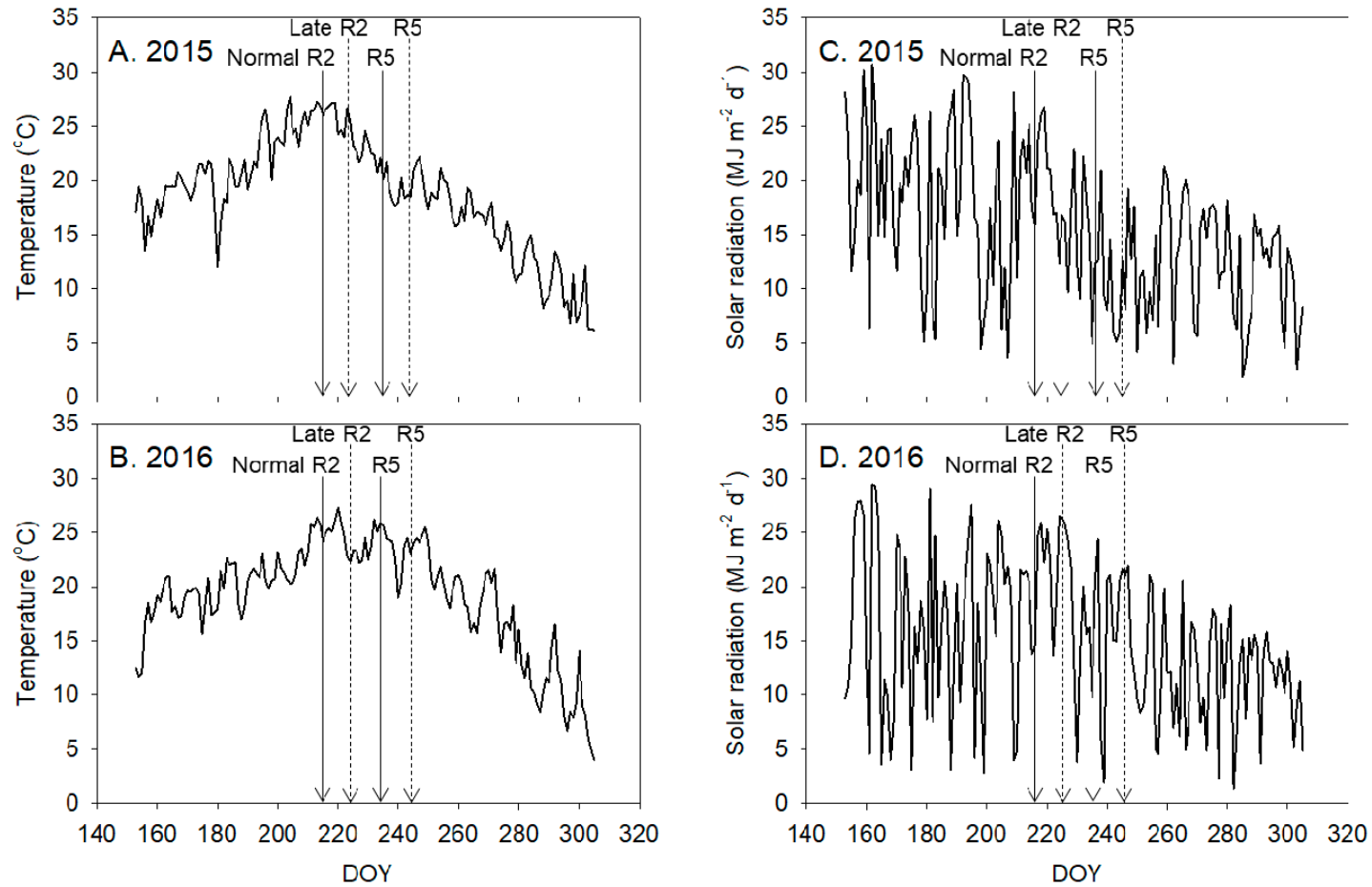23 Significance: ***p < 0.001; *p < 0.05; ns, not significant.

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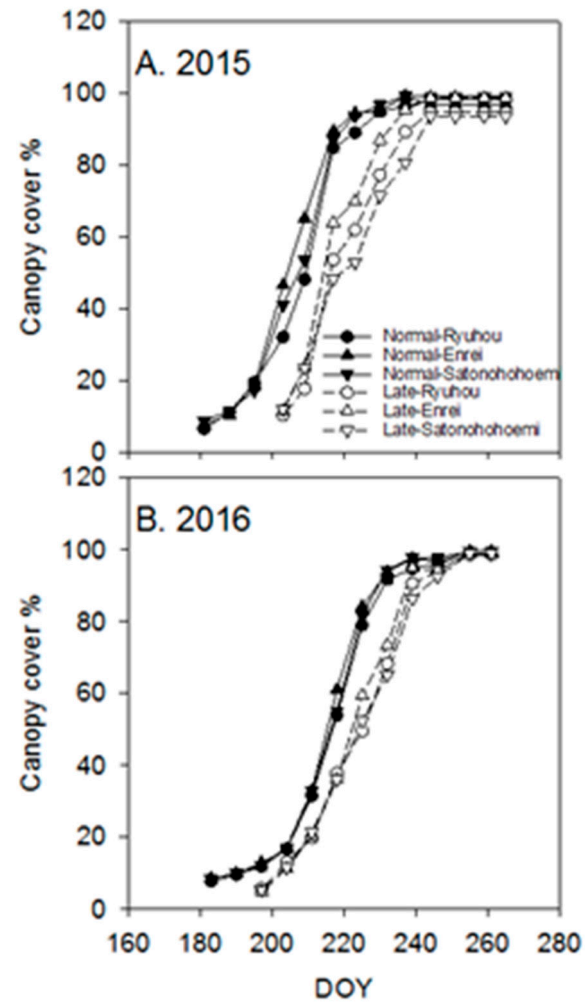
Figure S1. Changes in the canopy cover (%) of three soybean cultivars (Ryuhou, Enrei, Satonohohoemi) growing after normal and late sowing during the (A) 2015 and (B) 2016

seasons in the Tohoku region of northern Japan. DOY, day of the year. Values represent the mean (n = 3).

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Figure S2. Changes in daily mean temperature and solar radiation from June to October during the soybean growing season in (A and C) 2015 and (B and D) 2016 in the Tohoku region of northern Japan. DOY, day of the year. R2, beginning of flowering; R5, beginning of seed filling stage; | normal sowing date; ⁞ late sowing date; arrows indicate means of the three cultivars.