Table S1. Effects of nitrogen application rates and fertilization methods on primary branch traits of Koshihikari rice in 2024 and 2025.

Year	Treatment		Number of primary branches per panicle	Number of spikelets per primary branch	Seed setting rate of primary branches (%)	1000-grain weight of spikelets from primary branches (g)	Spikelets per centimeter of primary branch (cm^{-1})
2024	N0	FP	7.38±0.29a	49.52±0.88a	94.36±0.49a	26.47±0.18a	2.77±0.05a
		LSF	7.60±0.31a	50.37±0.50a	94.46±0.22a	26.41±0.17a	2.81±0.03a
		PQSF	7.44±0.11a	50.08±0.47a	94.61±0.15a	26.88±0.13a	2.81±0.03a
		Mean	**7.47±0.23^{c}**	**49.99±0.80^{d}**	**94.48±0.28^{a}**	**26.59±0.23^{ab}**	**2.80±0.04^{d}**
	N45	FP	7.37±0.24a	51.20±0.48a	95.50±0.22a	26.91±0.43a	2.90±0.02a
		LSF	7.99±0.15a	51.91±0.39a	94.53±0.02b	26.98±0.32a	2.86±0.03a
		PQSF	7.95±0.33a	52.52±0.46a	93.80±0.16c	26.40±0.07a	2.75±0.03b
		Mean	**7.77±0.27^{bc}**	**51.88±0.71^{c}**	**94.61±0.49^{a}**	**26.76±0.21^{a}**	**2.84±0.04^{d}**
	N90	FP	7.62±0.28a	52.47±0.49a	95.41±0.42a	25.72±0.11b	2.93±0.03b
		LSF	8.16±0.53a	53.92±0.39a	94.94±0.09a	26.91±0.31a	3.05±0.02a
		PQSF	8.17±0.49a	54.00±0.40a	93.43±0.15b	26.37±0.2ab	2.91±0.02b
		Mean	**7.98±0.31^{ab}**	**53.46±0.58^{b}**	**94.59±0.53^{a}**	**26.34±0.39^{ab}**	**2.96±0.04^{c}**
	N135	FP	8.17±0.36a	54.78±0.68b	93.18±0.32b	25.71±0.12b	3.06±0.02b
		LSF	8.33±0.06a	57.84±1.19a	94.25±0.14a	26.88±0.34a	3.17±0.06a
		PQSF	8.52±0.06a	55.77±1.04b	93.26±0.02b	26.00±0.16b	2.86±0.01c
		Mean	**8.34±0.29^{a}**	**56.13±0.86^{a}**	**93.56±0.33^{b}**	**26.2±0.39^{bc}**	**3.03±0.08^{b}**
	N180	FP	8.62±0.03a	56.53±0.50a	92.73±0.13b	25.17±0.39b	3.16±0.03a
		LSF	8.43±0.02a	54.87±0.33ab	94.06±0.08a	26.68±0.17a	3.23±0.04a
		PQSF	8.25±0.09a	54.30±0.55b	93.64±0.22a	25.80±0.31b	2.91±0.04b
		Mean	**8.44±0.22^{a}**	**55.23±0.75^{a}**	**93.48±0.39^{b}**	**25.88±0.44^{c}**	**3.10±0.09^{a}**
	F-value	F_N	**	**	**	**	**
		F_F	ns	ns	**	**	**
		$F_{N\times F}$	ns	ns	**	*	**
2025	N0	FP	7.67±0.16a	51.20±0.50b	93.11±0.38a	26.15±0.04b	2.76±0.03a
		LSF	7.73±0.13a	51.09±0.39b	93.34±0.26a	26.04±0.03c	2.79±0.02a
		PQSF	7.62±0.31a	53.73±0.62a	93.76±0.06a	26.33±0.06a	2.72±0.03a
		Mean	**7.67±0.19^{b}**	**52.01±0.87^{b}**	**93.40±0.29^{b}**	**26.17±0.08^{b}**	**2.76±0.03^{b}**
	N45	FP	7.57±0.14b	52.23±1.18a	93.56±0.46a	25.98±0.02a	2.89±0.07a
		LSF	8.10±0.14a	52.57±0.25a	92.57±0.25b	26.03±0.01a	2.88±0.01a
		PQSF	7.92±0.22ab	53.21±0.88a	92.45±0.14b	26.01±0.01a	2.89±0.05a
		Mean	**7.86±0.20^{ab}**	**52.67±0.79^{ab}**	**92.86±0.41^{ab}**	**26.01±0.02^{ab}**	**2.89±0.04^{ab}**
	N90	FP	8.16±0.08b	52.83±0.37b	92.72±0.24a	25.93±0.03a	2.91±0.02b
		LSF	8.38±0.15ab	54.25±0.71ab	92.92±0.20a	25.92±0.01a	3.01±0.04a

Year	Treatment		Number of primary branches per panicle	Number of spikelets per primary branch	Seed setting rate of primary branches (%)	1000-grain weight of spikelets from primary branches (g)	Spikelets per centimeter of primary branch (cm^{-1})
		PQSF	8.67±0.06a	55.07±0.20a	93.38±0.42a	25.88±0.05a	2.90±0.01b
		Mean	**8.40±0.16^{ab}**	**54.05±0.7^{ab}**	**93.00±0.31^{ab}**	**25.91±0.03^{ab}**	**2.94±0.04^{ab}**
	N135	FP	8.35±0.24a	54.65±0.37b	93.00±0.43a	25.75±0.05c	3.00±0.02a
		LSF	8.43±0.09a	57.74±0.47a	92.41±0.14a	25.91±0.02b	3.04±0.02a
		PQSF	8.62±0.08a	56.83±0.63a	92.54±0.05a	26.04±0.06a	3.03±0.03a
		Mean	**8.47±0.15^{a}**	**56.41±0.90^{a}**	**92.65±0.28^{a}**	**25.90±0.08^{a}**	**3.02±0.02^{a}**
	N180	FP	8.68±0.15a	56.77±0.30a	91.11±0.05b	25.91±0.04ab	3.06±0.02a
		LSF	8.77±0.04a	54.51±0.73b	92.51±0.41a	26.00±0.02a	3.13±0.04a
		PQSF	8.40±0.13a	54.12±0.54b	92.78±0.31a	25.85±0.01b	2.92±0.03b
		Mean	**8.61±0.14^{ab}**	**55.13±0.86^{ab}**	**92.13±0.52^{ab}**	**25.92±0.04^{ab}**	**3.04±0.06^{ab}**
	F-value	F_N	**	**	**	**	**
		F_F	ns	ns	ns	**	**
		$F_{N\times F}$	ns	**	**	**	ns
	F_Y		ns	ns	**	ns	ns
	$F_{Y\times N}$		ns	ns	ns	*	ns
	$F_{Y\times F}$		ns	ns	*	*	**
	$F_{Y\times N\times F}$		ns	ns	**	ns	*

Note: Different lowercase letters indicate significant differences between groups of the two factors ($p < 0.05$); * and ** indicate significant differences at the 0.05 and 0.01 levels, respectively; ns indicates non-significant differences. N, nitrogen treatment; F, fertilization method; Y, year. F_Y, $F_{Y\times N}$, $F_{Y\times F}$, and $F_{Y\times N\times F}$ represent the F-values for the year effect, year × nitrogen interaction, year × fertilization interaction, and year × nitrogen × fertilization interaction, respectively.

Table S2. Effects of nitrogen application rates and fertilization methods on secondary branch traits of Koshihikari rice in 2024 and 2025.

Year	Treatment		Number of secondary branches per panicle	Number of spikelets per secondary branch	Seed setting rate of secondary branches (%)	1000-grain weight of spikelets from secondary branches (g)	Spikelets per centimeter of secondary branch (cm^{-1})
2024	N0	FP	5.46±0.14b	23.85±0.58c	85.99±1.12a	24.39±0.12a	1.33±0.03c
		LSF	6.23±0.59ab	26.21±0.86b	84.63±0.56ab	24.70±0.27a	1.46±0.05b
		PQSF	6.83±0.57a	28.99±0.15a	83.65±0.48b	23.64±0.35b	1.62±0.01a
		Mean	**6.17±0.54^{c}**	**26.35±1.39^{d}**	**84.76±0.89^{bc}**	**24.24±0.36^{b}**	**1.47±0.08^{d}**
	N45	FP	7.60±0.19a	30.45±0.31a	78.58±0.64b	23.41±0.23b	1.70±0.02a
		LSF	7.18±0.47a	29.12±0.13b	76.04±0.35c	23.85±0.33ab	1.63±0.01b
		PQSF	5.88±0.84b	23.49±0.34c	87.07±0.24a	24.47±0.32a	1.31±0.02c

Year	Treatment		Number of secondary branches per panicle	Number of spikelets per secondary branch	Seed setting rate of secondary branches (%)	1000-grain weight of spikelets from secondary branches (g)	Spikelets per centimeter of secondary branch (cm^{-1})
2025	N90	**Mean**	**6.89±0.66^{b}**	**27.68±1.86^{c}**	**80.56±2.91^{d}**	**23.91±0.37^{b}**	**1.55±0.10^{b}**
		FP	6.78±0.22b	28.10±0.10c	86.33±0.22a	25.03±0.09a	1.57±0.01c
		LSF	8.13±0.53a	30.15±0.4b	85.39±0.53ab	25.01±0.38a	1.68±0.02b
		PQSF	8.64±0.35a	32.88±0.25a	84.69±0.29b	24.97±0.11a	1.84±0.01a
		Mean	**7.85±0.59^{a}**	**30.37±1.22^{a}**	**85.47±0.52^{b}**	**25.00±0.20^{a}**	**1.70±0.07^{a}**
	N135	FP	9.17±0.11a	30.82±0.11a	84.20±0.47c	24.6±0.13a	1.72±0.01a
		LSF	6.56±0.10b	24.49±0.59c	87.19±0.17b	23.9±0.03a	1.38±0.05b
		PQSF	6.43±0.18b	25.78±0.39b	90.46±0.37a	23.9±0.29a	1.40±0.03b
		Mean	**7.39±0.78^{ab}**	**27.03±1.71^{c}**	**87.28±1.6a**	**24.13±0.25^{b}**	**1.50±0.10^{cd}**
	N180	FP	7.33±0.28a	28.80±0.20ab	88.81±0.19a	23.96±0.20a	1.42±0.03b
		LSF	7.20±0.14a	27.91±0.41b	83.39±0.35b	23.12±0.17b	1.55±0.02a
		PQSF	7.57±0.02a	29.40±0.40a	79.88±0.46c	22.64±0.27b	1.58±0.01a
		Mean	**7.37±0.18^{ab}**	**28.70±0.48^{b}**	**84.03±2.27^{c}**	**23.24±0.38^{c}**	**1.52±0.05^{bc}**
	F-value	F_N	**	**	**	**	**
		F_F	ns	ns	**	ns	ns
		$F_{N\times F}$	**	**	**	**	**
	N0	FP	5.53±0.11b	23.87±0.25a	84.72±0.58a	23.91±0.12a	1.33±0.01a
		LSF	5.74±0.06ab	23.46±0.24a	84.39±0.46a	23.93±0.05a	1.31±0.01a
		PQSF	6.06±0.17a	24.00±0.45a	86.00±0.47a	23.86±0.15a	1.35±0.03a
		Mean	**5.78±0.17^{b}**	**23.77±0.32^{b}**	**85.03±0.61^{b}**	**23.90±0.10^{b}**	**1.33±0.02^{b}**
	N45	FP	5.92±0.06b	26.53±0.3b	83.92±0.36b	24.37±0.08a	1.48±0.02b
		LSF	6.52±0.23a	28.82±0.32a	85.66±0.34a	24.68±0.15a	1.61±0.02a
		PQSF	6.50±0.23a	26.97±0.46b	87.13±0.23a	23.44±0.23b	1.41±0.02c
		Mean	**6.31±0.24^{b}**	**27.44±0.69^{b}**	**85.57±0.85^{b}**	**24.16±0.35^{b}**	**1.50±0.05^{b}**
	N90	FP	6.45±0.11c	30.39±0.31ab	84.24±1.10b	23.89±0.22b	1.70±0.02b
		LSF	7.77±0.06a	31.20±0.38a	85.44±0.35ab	24.58±0.15a	1.76±0.02a
		PQSF	7.33±0.02b	30.04±0.27b	86.73±0.34a	24.11±0.13b	1.62±0.01c
		Mean	**7.18±0.34^{a}**	**30.54±0.41^{a}**	**85.47±0.87^{a}**	**24.19±0.23^{a}**	**1.69±0.04^{a}**
	N135	FP	7.39±0.12b	30.08±0.36b	79.97±0.55a	23.38±0.16b	1.81±0.02a
		LSF	8.19±0.10a	33.10±0.50a	81.54±0.71a	24.19±0.17a	1.68±0.03b
		PQSF	7.61±0.13b	30.93±0.32b	81.49±1.17a	23.98±0.06a	1.59±0.02c
		Mean	**7.73±0.23^{a}**	**31.37±0.85^{a}**	**81.00±0.86^{a}**	**23.85±0.24^{a}**	**1.69±0.06^{a}**
	N180	FP	7.66±0.10b	31.02±0.49a	78.37±0.10c	23.91±0.07ab	1.73±0.03b
		LSF	8.48±0.09a	31.48±0.35a	82.16±0.61a	24.27±0.17a	1.85±0.02a
		PQSF	7.73±0.11b	30.45±0.30a	80.19±0.63b	23.50±0.19b	1.63±0.02c

Year	Treatment		Number of secondary branches per panicle	Number of spikelets per secondary branch	Seed setting rate of secondary branches (%)	1000-grain weight of spikelets from secondary branches (g)	Spikelets per centimeter of secondary branch (cm^{-1})
		Mean	**7.95±0.24^{a}**	**30.98±0.43^{a}**	**80.24±1.05^{a}**	**23.89±0.23^{a}**	**1.74±0.06^{a}**
	F-value	F_N	**	**	**	*	**
		F_F	ns	ns	**	ns	**
		$F_{N\times F}$	**	**	*	**	**
	F_Y		ns	ns	*	ns	*
	$F_{Y\times N}$		ns	**	ns	ns	**
	$F_{Y\times F}$		ns	ns	**	**	ns
	$F_{Y\times N\times F}$		ns	ns	**	ns	ns

Note: Different lowercase letters indicate significant differences between groups of the two factors ($p < 0.05$); * and ** indicate significant differences at the 0.05 and 0.01 levels, respectively; ns indicates non-significant differences. N, nitrogen treatment; F, fertilization method; Y, year. F_Y, $F_{Y\times N}$, $F_{Y\times F}$, and $F_{Y\times N\times F}$ represent the F-values for the year effect, year × nitrogen interaction, year × fertilization interaction, and year × nitrogen × fertilization interaction, respectively.

Table S3. Effects of nitrogen application rates and fertilization methods on milling quality of Koshihikari rice in 2024 and 2025.

Year	Treatment		Brown rice rate (%)	Milled rice rate (%)	Head rice rate (%)
2024	N0	FP	77.37±0.42b	67.99±0.42c	61.85±0.42a
		LSF	79.34±0.12a	70.51±0.12b	61.60±0.12a
		PQSF	79.47±0.19a	71.82±0.19a	62.18±0.19a
		Mean	**78.72±0.63^{d}**	**70.11±1.00^{c}**	**61.88±0.18^{b}**
	N45	FP	77.74±0.25c	70.27±0.25b	65.31±0.25a
		LSF	80.59±0.08a	71.58±0.08a	63.77±0.08b
		PQSF	79.34±0.08b	71.68±0.08a	63.67±0.08b
		Mean	**79.22±0.73^{ab}**	**71.18±0.43^{ab}**	**64.25±0.48^{a}**
	N90	FP	78.10±0.07c	70.54±0.07c	62.24±0.07c
		LSF	80.71±0.26a	72.4±0.26a	66.24±0.26a
		PQSF	79.68±0.07b	71.38±0.07b	65.00±0.07b
		Mean	**79.50±0.67^{a}**	**71.44±0.50^{a}**	**64.49±1.04^{a}**
	N135	FP	78.15±0.37b	70.57±0.37b	62.55±0.37b
		LSF	79.02±0.07a	71.50±0.07a	59.71±0.07c
		PQSF	79.40±0.06a	71.61±0.06a	63.33±0.06a
		Mean	**78.86±0.37^{cd}**	**71.23±0.34^{ab}**	**61.86±0.98^{b}**
	N180	FP	79.68±0.11a	71.68±0.11a	60.76±0.11b
		LSF	78.49±0.12b	70.57±0.12b	57.76±0.12c

Year	Treatment		Brown rice rate (%)	Milled rice rate (%)	Head rice rate (%)
2025		PQSF	79.23±0.02a	70.86±0.02b	63.62±0.02a
		Mean	**79.13±0.31^{bc}**	**71.04±0.34^{b}**	**60.71±1.48^{c}**
	F-value	F_N	**	**	**
		F_F	**	**	**
		$F_{N\times F}$	**	**	**
	N0	FP	78.50±0.38b	69.83±0.34c	62.92±0.39a
		LSF	80.32±0.44a	72.31±0.20a	62.61±0.36a
		PQSF	79.28±0.23b	71.15±0.11b	63.02±0.08a
		Mean	**79.37±0.54^{c}**	**71.10±0.67^{c}**	**62.85±0.35^{c}**
	N45	FP	79.05±0.32b	70.52±0.09c	66.07±0.16a
		LSF	80.89±0.22a	72.85±0.01a	64.34±0.24b
		PQSF	79.79±0.11b	71.86±0.18b	64.11±0.30b
		Mean	**79.91±0.54^{b}**	**71.74±0.63^{b}**	**64.84±0.58^{b}**
	N90	FP	79.66±0.17b	71.75±0.23b	62.92±0.10b
		LSF	81.53±0.18a	73.49±0.09a	65.61±0.23a
		PQSF	80.29±0.23b	72.43±0.44b	64.89±0.28a
		Mean	**80.50±0.50^{a}**	**72.56±0.45^{a}**	**64.47±0.71^{a}**
	N135	FP	79.68±0.15b	72.03±0.05b	62.85±0.04b
		LSF	81.21±0.43a	73.12±0.33a	61.59±0.45c
		PQSF	80.21±0.33b	72.16±0.37b	64.16±0.26a
		Mean	**80.37±0.45^{ab}**	**72.44±0.39^{ab}**	**62.87±0.69^{ab}**
	N180	FP	79.96±0.11ab	72.62±0.14a	61.55±0.07b
		LSF	80.59±0.23a	72.26±0.24a	60.20±0.37c
		PQSF	79.51±0.17b	71.52±0.18b	63.51±0.20a
		Mean	**80.02±0.31^{b}**	**72.13±0.30^{b}**	**61.75±0.85^{b}**
	F-value	F_N	**	**	**
		F_F	*	**	**
		$F_{N\times F}$	ns	**	**
	F_Y		ns	ns	ns
	$F_{Y\times N}$		ns	ns	*
	$F_{Y\times F}$		*	**	ns
	$F_{Y\times N\times F}$		**	*	*

Note: Different lowercase letters indicate significant differences between groups of the two factors ($p < 0.05$); * and ** indicate significant differences at the 0.05 and 0.01 levels, respectively; ns indicates non-significant differences. N, nitrogen treatment; F, fertilization method; Y, year. F_Y, $F_{Y\times N}$, $F_{Y\times F}$, and $F_{Y\times N\times F}$ represent the F-values for the year effect, year × nitrogen interaction, year × fertilization interaction, and year × nitrogen × fertilization interaction, respectively.

Table S4. Effects of nitrogen application rates and fertilization methods on nutritional and appearance quality of Koshihikari rice in 2024 and 2025.

Year	Treatment		Chalkiness degree (%)	Chalkiness percentage (%)	Moisture Content (%)	Protein content (%)	Amylose content (%)	Acid Value (%)
2024	N0	FP	1.10±0.06a	5.33±0.12a	8.83±0.03b	5.43±0.03b	19.90±0.01a	14.00±0.06b
		LSF	1.00±0.06a	5.07±0.09a	8.87±0.03b	5.47±0.03ab	19.70±0.01c	14.23±0.03a
		PQSF	1.13±0.03a	4.97±0.12a	9.10±0.01a	5.57±0.03a	19.83±0.03b	14.07±0.03b
		Mean	**1.08±0.14^{e}**	**5.12±0.13^{e}**	**8.93±0.08^{c}**	**5.49±0.05^{e}**	**19.81±0.05^{a}**	**14.10±0.07^{c}**
	N45	FP	1.37±0.07b	6.13±0.48a	9.37±0.03a	5.60±0.06a	19.80±0.01a	14.23±0.03a
		LSF	1.63±0.03a	6.53±0.07a	9.40±0.01a	5.60±0.01a	19.70±0.01b	14.27±0.03a
		PQSF	1.40±0.06b	6.47±0.18a	8.90±0.01b	5.60±0.01a	19.80±0.01a	14.20±0.01a
		Mean	**1.47±0.09^{d}**	**6.38±0.28^{d}**	**9.22±0.14^{b}**	**5.60±0.03^{d}**	**19.77±0.03^{b}**	**14.23±0.03^{a}**
	N90	FP	1.53±0.10b	8.17±0.12a	9.40±0.01a	5.70±0.01a	19.63±0.03b	14.13±0.03a
		LSF	1.80±0.03a	7.83±0.12a	9.20±0.01b	5.60±0.01a	19.60±0.01b	14.03±0.03b
		PQSF	1.57±0.03b	6.83±0.03b	9.40±0.01a	5.70±0.01a	19.80±0.01a	14.00±0.01b
		Mean	**1.63±0.08^{c}**	**7.61±0.36^{c}**	**9.33±0.08^{a}**	**5.67±0.03^{c}**	**19.68±0.06^{c}**	**14.06±0.04^{c}**
	N135	FP	1.90±0.10b	9.77±0.18a	9.10±0.01c	5.83±0.03ab	19.60±0.01b	14.20±0.06b
		LSF	2.17±0.03a	8.20±0.06b	9.30±0.01a	5.93±0.07a	19.60±0.01b	14.30±0.01a
		PQSF	2.07±0.03ab	7.77±0.22b	9.20±0.01b	5.80±0.06b	19.73±0.03a	14.13±0.03b
		Mean	**2.04±0.09^{b}**	**8.58±0.55^{b}**	**9.20±0.05^{b}**	**5.86±0.06^{b}**	**19.64±0.04^{d}**	**14.21±0.05^{ab}**
	N180	FP	2.80±0.15a	10.80±0.06a	9.20±0.01a	6.17±0.03a	19.53±0.03b	14.17±0.03ab
		LSF	2.47±0.03b	9.20±0.17b	9.20±0.01a	6.23±0.07a	19.43±0.03c	14.23±0.03a
		PQSF	2.37±0.07b	9.53±0.07b	9.20±0.01a	5.97±0.03b	19.70±0.01a	14.10±0.01b
		Mean	**2.54±0.06^{a}**	**9.84±0.43^{a}**	**9.20±0.01^{b}**	**6.12±0.08^{a}**	**19.56±0.07^{e}**	**14.17±0.04^{b}**
	F-value	F_N	**	**	**	**	**	**
		F_F	ns	**	ns	ns	**	**
		$F_{N\times F}$	**	**	**	**	**	**
2025	N0	FP	1.10±0.01a	5.43±0.12a	8.87±0.07b	5.40±0.01a	19.87±0.03a	14.27±0.03ab
		LSF	0.93±0.06a	5.33±0.07a	9.03±0.03a	5.37±0.06a	19.80±0.03a	14.23±0.03b
		PQSF	1.03±0.01a	5.07±0.09a	9.07±0.06a	5.40±0.03a	19.87±0.03a	14.33±0.06a
		Mean	**1.02±0.05^{e}**	**5.28±0.14^{e}**	**8.99±0.07^{c}**	**5.39±0.02^{e}**	**19.84±0.03^{a}**	**14.28±0.04^{a}**
	N45	FP	1.30±0.07b	7.73±0.06a	9.27±0.03a	5.60±0.03a	19.77±0.03a	14.37±0.01a
		LSF	1.47±0.09a	6.23±0.09b	9.23±0.03a	5.53±0.03a	19.70±0.01a	14.17±0.03b
		PQSF	1.27±0.03b	6.17±0.13b	9.33±0.03a	5.57±0.03a	19.77±0.01a	14.13±0.03b
		Mean	**1.34±0.07^{d}**	**6.71±0.45^{d}**	**9.28±0.04^{a}**	**5.57±0.04^{d}**	**19.74±0.03^{b}**	**14.22±0.07^{bc}**
	N90	FP	1.40±0.03b	8.33±0.15a	9.30±0.03a	5.63±0.03b	19.67±0.01ab	14.10±0.03c
		LSF	1.77±0.03a	7.40±0.12b	9.27±0.03a	5.77±0.07a	19.60±0.01b	14.30±0.01b
		PQSF	1.50±0.03b	6.53±0.03c	9.23±0.03a	5.63±0.02b	19.73±0.03a	14.40±0.03a
		Mean	**1.56±0.10^{c}**	**7.42±0.46^{c}**	**9.27±0.04^{a}**	**5.68±0.06^{c}**	**19.67±0.04^{c}**	**14.27±0.08^{ab}**

Year	Treatment		Chalkiness degree (%)	Chalkiness percentage (%)	Moisture Content (%)	Protein content (%)	Amylose content (%)	Acid Value (%)
	N135	FP	2.07±0.09a	9.60±0.22a	9.10±0.03a	5.73±0.03a	19.57±0.01b	14.10±0.01b
		LSF	2.03±0.03a	8.27±0.12b	9.17±0.03a	5.78±0.01a	19.57±0.03b	14.23±0.03a
		PQSF	2.17±0.03a	8.20±0.12b	9.17±0.06a	5.73±0.03a	19.70±0.03a	14.30±0.03a
		Mean	**2.09±0.07^{b}**	**8.69±0.40^{b}**	**9.14±0.03^{b}**	**5.75±0.03^{b}**	**19.61±0.05^{d}**	**14.21±0.06^{c}**
	N180	FP	3.03±0.06a	10.03±0.15a	9.23±0.11a	5.83±0.03a	19.50±0.03b	14.33±0.01a
		LSF	2.37±0.09b	9.37±0.12b	9.13±0.23a	5.83±0.03a	19.40±0.01c	14.20±0.06b
		PQSF	2.43±0.09b	8.77±0.09c	9.20±0.17a	5.80±0.06a	19.70±0.01a	14.33±0.03a
		Mean	**2.61±0.20^{a}**	**9.39±0.34^{a}**	**9.19±0.05^{b}**	**5.82±0.04^{a}**	**19.53±0.08^{e}**	**14.29±0.05^{a}**
	F-value	F_N	ns	**	**	**	**	**
		F_F	*	**	ns	ns	**	**
		$F_{N\times F}$	**	**	*	ns	**	**
	F_Y		ns	ns	ns	ns	ns	**
	$F_{Y\times N}$		*	**	**	ns	ns	**
	$F_{Y\times F}$		ns	ns	ns	ns	ns	**
	$F_{Y\times N\times F}$		ns	**	**	ns	ns	**

Note: Different lowercase letters indicate significant differences between groups of the two factors ($p < 0.05$); * and ** indicate significant differences at the 0.05 and 0.01 levels, respectively; ns indicates non-significant differences. N, nitrogen treatment; F, fertilization method; Y, year. F_Y, $F_{Y\times N}$, $F_{Y\times F}$, and $F_{Y\times N\times F}$ represent the F-values for the year effect, year × nitrogen interaction, year × fertilization interaction, and year × nitrogen × fertilization interaction, respectively.

Table S5. Effects of nitrogen application rates and fertilization methods on cooking and eating quality of Koshihikari rice in 2024 and 2025.

Year	Treatment		Appearance	Hardness	Viscosity	Balance	Taste value
2024	N0	FP	8.47±0.09a	5.90±0.06a	8.90±0.12a	8.53±0.12a	84.00±0.58a
		LSF	8.50±0.01a	5.93±0.09a	8.80±0.15a	8.43±0.17a	83.33±0.33a
		PQSF	8.57±0.03a	5.67±0.03a	8.80±0.06a	8.67±0.03a	84.00±0.58a
		Mean	**8.51±0.05^{a}**	**5.83±0.09^{bc}**	**8.83±0.10^{a}**	**8.54±0.12^{a}**	**83.78±0.48^{a}**
	N45	FP	7.77±0.03b	6.13±0.03a	8.37±0.34b	7.93±0.29b	79.33±0.33b
		LSF	8.80±0.10a	5.53±0.03b	9.23±0.19a	8.93±0.13a	85.67±0.67a
		PQSF	8.73±0.07a	5.47±0.09b	9.1±0.15ab	8.90±0.15a	86.33±0.88a
		Mean	**8.43±0.30^{a}**	**5.71±0.19^{c}**	**8.90±0.31^{a}**	**8.59±0.33^{a}**	**83.78±2.02^{a}**
	N90	FP	7.43±0.07c	6.20±0.12a	8.10±0.23a	7.67±0.19b	77.33±0.67b
		LSF	8.43±0.07a	5.80±0.06b	8.80±0.06a	8.53±0.09a	81.67±0.33a
		PQSF	8.00±0.06b	5.73±0.18b	8.60±0.25a	8.00±0.10ab	81.33±0.88a
		Mean	**7.96±0.26^{b}**	**5.91±0.17^{b}**	**8.50±0.25^{ab}**	**8.07±0.25^{b}**	**80.11±1.34^{b}**
	N135	FP	7.33±0.03b	6.23±0.09a	8.00±0.15a	7.60±0.01a	76.00±0.01b

		LSF	8.17±0.03a	6.10±0.15a	8.20±0.17a	7.80±0.26a	77.00±0.58b
		PQSF	8.10±0.06a	5.67±0.15b	7.97±0.53a	7.77±0.24a	79.67±0.88a
		Mean	**7.87±0.23^{b}**	**6.00±0.19^{ab}**	**8.06±0.3^{bc}**	**7.72±0.19^{c}**	**77.56±1.08^{c}**
	N180	FP	7.03±0.03b	6.33±0.07a	8.17±0.24a	7.53±0.17b	75.00±0.58b
		LSF	6.87±0.35b	6.03±0.27ab	7.30±0.55b	7.03±0.38b	72.33±0.33c
		PQSF	7.90±0.06a	5.97±0.09b	8.53±0.03a	8.13±0.13a	79.67±0.67a
		Mean	**7.27±0.33^{c}**	**6.11±0.18^{a}**	**8.00±0.44^{c}**	**7.57±0.35^{c}**	**75.67±1.91^{d}**
	F-value	F_N	**	**	ns	**	**
		F_F	**	**	**	**	**
		$F_{N\times F}$	**	ns	ns	**	**
	N0	FP	8.50±0.06a	5.87±0.03a	8.97±0.09a	8.67±0.03a	84.67±0.11a
		LSF	8.60±0.03a	5.83±0.03a	8.90±0.19a	8.53±0.23a	85.33±0.29a
		PQSF	8.57±0.03a	5.60±0.09a	8.80±0.06a	8.57±0.06a	84.67±0.29a
		Mean	**8.56±0.05^{a}**	**5.77±0.08^{bc}**	**8.89±0.07^{a}**	**8.59±0.07^{a}**	**84.89±0.35^{a}**
	N45	FP	7.83±0.06c	6.07±0.09a	8.37±0.10b	8.00±0.09b	80.67±0.01c
		LSF	8.90±0.03a	5.50±0.09b	9.33±0.21a	8.93±0.03a	84.33±0.29b
		PQSF	8.73±0.06b	5.50±0.03b	9.13±0.06a	8.97±0.12a	86.33±0.11a
		Mean	**8.49±0.29^{a}**	**5.69±0.17^{c}**	**8.94±0.29^{a}**	**8.63±0.31^{a}**	**83.78±1.47^{b}**
	N90	FP	7.53±0.06c	6.13±0.06a	8.20±0.15b	7.30±0.13b	79.67±0.11c
		LSF	8.47±0.03a	5.73±0.09b	8.83±0.03a	8.53±0.09a	85.00±0.33a
		PQSF	8.20±0.03b	5.50±0.12b	8.47±0.09ab	8.13±0.20a	83.67±0.29b
2025		**Mean**	**8.07±0.24^{b}**	**5.79±0.17^{bc}**	**8.50±0.17^{b}**	**7.99±0.33^{b}**	**82.78±1.47^{c}**
	N135	FP	7.40±0.12c	6.13±0.20a	8.10±0.40a	7.77±0.29a	78.00±0.29b
		LSF	8.23±0.03a	5.97±0.06a	8.03±0.06a	7.90±0.03a	78.33±0.29b
		PQSF	8.07±0.07b	5.63±0.06b	8.33±0.13a	8.07±0.15a	80.33±0.29a
		Mean	**7.90±0.22^{c}**	**5.91±0.15^{b}**	**8.16±0.15^{c}**	**7.91±0.14^{b}**	**78.89±0.67^{d}**
	N180	FP	7.07±0.06b	6.37±0.06a	8.57±0.09a	7.67±0.13a	75.67±0.59b
		LSF	7.07±0.03b	6.40±0.03a	8.00±0.22b	6.93±0.09b	75.33±0.11b
		PQSF	7.93±0.07a	5.67±0.09b	7.10±0.03c	7.70±0.20a	80.33±0.29a
		Mean	**7.36±0.26^{d}**	**6.14±0.24^{a}**	**7.89±0.43^{c}**	**7.43±0.28^{c}**	**77.11±1.43^{e}**
	F-value	F_N	**	**	**	**	**
		F_F	**	**	**	**	**
		$F_{N\times F}$	**	ns	ns	**	**
	F_Y		*	ns	ns	ns	ns
	$F_{Y\times N}$		ns	ns	ns	ns	*
	$F_{Y\times F}$		ns	ns	ns	ns	ns
	$F_{Y\times N\times F}$		ns	ns	ns	ns	ns

Note: Different lowercase letters indicate significant differences between groups of the two factors ($p < 0.05$); * and ** indicate significant differences at the 0.05 and 0.01 levels, respectively; ns indicates non-significant differences. N, nitrogen treatment; F, fertilization method; Y, year.

F_Y, $F_{Y\times N}$, $F_{Y\times F}$, and $F_{Y\times N\times F}$ represent the F-values for the year effect, year × nitrogen interaction, year × fertilization interaction, and year × nitrogen × fertilization interaction, respectively.

Table S6. Grain-filling parameters of superior and inferior grains under different nitrogen application rates and fertilization methods.

Treatment		Grain Position	R0	Tmax (d)	Gmax (mg grain^{-1} d^{-1})	Wmax (mg grain^{-1})	I (%)	Gmean (mg grain^{-1} d^{-1})	D (d)	T99 (d)
N0	FP	SG	0.27	13.88	1.20	11.88	0.46	0.81	32.32	36.87
	LSF	SG	0.32	13.60	1.19	11.61	0.44	0.80	32.86	37.58
	PQSF	SG	0.38	13.37	1.15	11.16	0.43	0.78	33.57	37.56
	FP	IG	0.08	33.97	1.20	17.92	0.73	0.72	33.90	43.04
	LSF	IG	0.08	32.91	1.23	17.72	0.73	0.74	32.96	42.20
	PQSF	IG	0.08	33.14	1.25	17.73	0.74	0.75	31.88	41.30
N45	FP	SG	0.20	13.86	1.29	12.96	0.50	0.86	30.12	40.47
	LSF	SG	0.27	13.35	1.21	12.01	0.46	0.81	32.30	41.96
	PQSF	SG	0.43	12.96	1.13	11.04	0.42	0.76	34.55	40.04
	FP	IG	0.10	30.76	1.30	16.41	0.67	0.81	30.32	42.27
	LSF	IG	0.10	30.52	1.31	16.58	0.67	0.82	30.37	42.17
	PQSF	IG	0.11	29.55	1.26	15.09	0.63	0.80	29.92	43.07
N90	FP	SG	0.76	13.06	1.14	10.26	0.40	0.77	33.40	42.57
	LSF	SG	0.80	12.44	1.19	10.34	0.38	0.81	33.61	43.91
	PQSF	SG	0.82	11.83	1.32	10.01	0.38	0.90	29.09	42.34
	FP	IG	0.10	29.93	1.31	15.85	0.68	0.81	28.87	40.58
	LSF	IG	0.10	28.84	1.10	15.29	0.61	0.71	35.45	46.58
	PQSF	IG	0.11	28.69	1.06	14.24	0.59	0.68	35.26	47.91
N135	FP	SG	0.41	12.69	1.42	11.21	0.44	0.96	26.56	44.80
	LSF	SG	0.44	12.36	1.48	11.44	0.43	1.00	26.47	45.94
	PQSF	SG	0.40	12.79	1.32	11.25	0.43	0.89	29.13	44.13
	FP	IG	0.13	27.98	1.18	13.47	0.59	0.77	30.07	44.70
	LSF	IG	0.13	27.72	1.20	14.16	0.57	0.78	31.85	46.64
	PQSF	IG	0.12	28.73	1.26	14.15	0.62	0.81	28.53	42.64
N180	FP	SG	0.52	12.08	1.32	10.26	0.38	0.90	29.79	47.38
	LSF	SG	0.45	12.67	1.35	11.03	0.43	0.91	28.28	49.63
	PQSF	SG	0.80	12.30	1.31	10.21	0.40	0.89	28.63	48.44
	FP	IG	0.12	28.48	1.24	14.43	0.61	0.80	29.86	43.74
	LSF	IG	0.16	26.71	1.04	11.90	0.52	0.69	33.43	50.70
	PQSF	IG	0.12	28.28	1.25	14.86	0.61	0.80	30.66	43.96

Table S7. Benjamini-Hochberg FDR correction results for protein fraction data

Protein fraction	Time (DAF)	Effect	Raw P-value	Adjusted Q-value	Significance
Albumin	10	N	0.0001	0.0003	**
Albumin	10	F	0.0001	0.0003	**
Albumin	10	N × F	0.0001	0.0003	**
Albumin	20	N	0.0001	0.0003	**
Albumin	20	F	0.0004	0.0005	**
Albumin	20	N × F	0.7355	0.7355	ns
Albumin	30	N	0.0001	0.0003	**
Albumin	30	F	0.0001	0.0003	**
Albumin	30	N × F	0.0001	0.0003	**
Albumin	40	N	0.0001	0.0003	**
Albumin	40	F	0.0001	0.0003	**
Albumin	40	N × F	0.0542	0.0573	ns
Albumin	50	N	0.0001	0.0003	**
Albumin	50	F	0.0002	0.0003	**
Albumin	50	N × F	0.0038	0.0043	**
Globulin	10	N	0.0001	0.0003	**
Globulin	10	F	0.0001	0.0003	**
Globulin	10	N × F	0.0007	0.0008	**
Globulin	20	N	0.0001	0.0003	**
Globulin	20	F	0.0001	0.0003	**
Globulin	20	N × F	0.0340	0.0358	*
Globulin	30	N	0.0001	0.0003	**
Globulin	30	F	0.0531	0.0554	ns
Globulin	30	N × F	0.0001	0.0003	**
Globulin	40	N	0.0001	0.0003	**
Globulin	40	F	0.0001	0.0003	**
Globulin	40	N × F	0.0302	0.0324	*
Globulin	50	N	0.0001	0.0003	**
Globulin	50	F	0.0001	0.0003	**
Globulin	50	N × F	0.0095	0.0106	*
Prolamin	10	N	0.0001	0.0003	**
Prolamin	10	F	0.0001	0.0003	**
Prolamin	10	N × F	0.0005	0.0006	**
Prolamin	20	N	0.0001	0.0003	**
Prolamin	20	F	0.0001	0.0003	**
Prolamin	20	N × F	0.0483	0.0522	ns
Prolamin	30	N	0.0001	0.0003	**
Prolamin	30	F	0.0001	0.0003	**
Prolamin	30	N × F	0.0001	0.0003	**
Prolamin	40	N	0.0001	0.0003	**
Prolamin	40	F	0.0001	0.0003	**
Prolamin	40	N × F	0.0001	0.0003	**
Prolamin	50	N	0.0001	0.0003	**
Prolamin	50	F	0.0001	0.0003	**
Prolamin	50	N × F	0.0001	0.0003	**
Glutelin	10	N	0.0001	0.0003	**

Protein fraction	Time (DAF)	Effect	Raw P-value	Adjusted Q-value	Significance
Glutelin	10	F	0.0001	0.0003	**
Glutelin	10	N × F	0.6329	0.6436	ns
Glutelin	20	N	0.0001	0.0003	**
Glutelin	20	F	0.0001	0.0003	**
Glutelin	20	N × F	0.0230	0.0251	*
Glutelin	30	N	0.0001	0.0003	**
Glutelin	30	F	0.0001	0.0003	**
Glutelin	30	N × F	0.0001	0.0003	**
Glutelin	40	N	0.0001	0.0003	**
Glutelin	40	F	0.0001	0.0003	**
Glutelin	40	N × F	0.0018	0.0021	**
Glutelin	50	N	0.0001	0.0003	**
Glutelin	50	F	0.0001	0.0003	**
Glutelin	50	N × F	0.0014	0.0016	**

Note: FDR correction was performed using the Benjamini-Hochberg procedure on all 60 p-values obtained from the two-way ANOVA of protein fractions at each sampling time point. Adjusted Q-values are shown. ** indicates adjusted Q < 0.01; * indicates adjusted Q < 0.05; ns indicates not significant (Q > 0.05). DAF, days after flowering; N, nitrogen application rate; F, fertilization method.

Table S8. Linear mixed-effects model results for protein fractions

Protein fraction	N (F, P)	F (F, P)	Time (F, P)	N × Time (F, P)	F × Time (F, P)	N × F (F, P)	AR1 Rho (P)	N × F × Time (F, P)	Model Comparison (AIC)
Albumin	405.21, <0.001	8.02, <0.001	1435.11, <0.001	36.12, <0.001	14.42, <0.001	3.13, 0.005	0.075 (0.383)	3.03, <0.001	Without AR(1): -914.75 With AR(1): -912.77
Globulin	295.53, <0.001	80.81, <0.001	883.39, <0.001	1.14, 0.325	4.34, <0.001	10.22, <0.001	-0.012 (0.877)	1.38, 0.115	Without AR(1): -845.38 With AR(1): -843.58
Prolamin	501.85, <0.001	153.50, <0.001	3543.12, <0.001	23.85, <0.001	30.10, <0.001	15.98, <0.001	0.145 (0.122)	5.85, <0.001	Without AR(1): -907.40 With AR(1): -905.74
Glutelin	293.46, <0.001	40.79, <0.001	4668.53, <0.001	10.97, <0.001	35.54, <0.001	4.55, <0.001	0.131 (0.104)	3.45, <0.001	Without AR(1): -245.33 With AR(1): -244.63

Note: For each protein fraction, a linear mixed-effects model was fitted with N, F, and Time as fixed effects, including the N × F × Time interaction. Model comparisons based on Akaike Information Criterion (AIC) were performed to evaluate the necessity of the AR(1) covariance structure. For all fractions, models without the AR(1) structure yielded lower AIC values than those with AR(1), indicating negligible residual temporal correlation. Therefore, the simpler models were preferred to avoid over-parameterization. Values are F-values and P-values for fixed effects. N, nitrogen application rate; F, fertilization method.

Table S9. Factor loadings of principal component analysis for quality-related traits (X1–X40).

Index number	Composition			
	PC1	PC2	PC3	PC4
X1	-0.00528	0.42456	-0.14142	0.12283
X2	0.04123	0.37038	-0.04466	0.24267
X3	-0.08362	0.19948	0.34087	0.34632
X4	0.18015	0.12526	0.01139	-0.11552
X5	0.18496	0.06395	0.08893	-0.1088
X6	0.08469	0.09368	0.10524	0.63629
X7	0.18142	0.01854	-0.02416	-0.16012
X8	-0.16413	-0.03884	0.28885	0.00559
X9	0.05059	-0.0323	-0.35195	0.05063
X10	-0.16359	0.20875	-0.06439	-0.01227
X11	0.10728	-0.25392	0.03313	0.08783
X12	-0.13312	0.1985	0.01879	-0.05318
X13	-0.15384	0.21454	-0.04312	-0.03533
X14	-0.17862	0.18056	0.0125	-0.07074
X15	0.17723	-0.173	0.05702	0.03895
X16	0.15246	-0.19549	0.10603	0.26025
X17	-0.17942	0.13449	0.06345	-0.05559
X18	0.15481	-0.21022	0.06259	0.00221
X19	0.15572	-0.10166	0.05632	0.24876
X20	-0.13838	0.14781	0.12764	-0.06524
X21	0.14654	0.13373	0.27943	-0.03233
X22	0.0861	0.18278	0.35634	-0.26668
X23	0.18661	0.05173	-0.10924	-0.01784
X24	0.18935	0.01416	0.04566	-0.06918
X25	0.18451	0.05227	0.17025	0.02041
X26	0.18297	0.10606	0.00695	-0.08959
X27	0.15977	0.14924	-0.22093	-0.0589
X28	0.18077	0.09012	-0.03512	0.1549
X29	0.16848	0.12661	-0.15292	-0.00559
X30	0.18019	0.11868	-0.1096	-0.04085
X31	0.18123	0.0715	-0.19285	-0.02517
X32	0.17811	0.0008	0.18513	-0.13898
X33	0.17861	-0.04781	0.02998	-0.09038
X34	0.19032	0.03861	0.06249	-0.06368
X35	0.18094	-0.05251	0.07704	0.04863
X36	0.17858	0.09535	0.05889	0.06895
X37	0.1461	0.12673	0.29435	-0.09378
X38	0.1829	0.07479	-0.04211	-0.05544
X39	0.1542	0.09282	-0.27823	0.11731
X40	0.16498	0.20728	0.01559	-0.11218

Table S10. Factor loadings of principal component analysis for yield-related traits (X41–X71).

Index number	Composition			
	PC1	PC2	PC3	PC4
X41	0.10463	-0.27051	-0.31475	0.17256

Index number	Composition			
	PC1	PC2	PC3	PC4
X42	-0.20514	0.08919	0.21378	0.05913
X43	0.18122	0.14064	0.2223	-0.24096
X44	-0.12155	0.16678	0.42881	-0.00264
X45	-0.11226	0.20145	0.4187	-0.0576
X46	0.18776	0.13006	0.19961	-0.24082
X47	-0.17765	-0.16003	-0.19204	0.28652
X48	-0.21269	0.04122	-0.00926	-0.02845
X49	0.19243	0.19373	-0.02677	0.16526
X50	0.22841	0.02238	-0.01971	0.04189
X51	0.21791	0.08304	0.08854	-0.00771
X52	-0.23107	-0.03938	0.01429	-0.08546
X53	-0.13006	0.36277	-0.10275	0.22759
X54	-0.2267	-0.01309	-0.02129	0.05708
X55	-0.23336	0.02052	-0.06099	0.00653
X56	-0.0353	0.42161	-0.10168	0.26241
X57	0.00806	-0.43804	0.13028	-0.13517
X58	-0.23405	0.03334	-0.01893	-0.05111
X59	0.21314	-0.19611	0.09303	-0.03374
X60	0.22503	-0.12301	0.10601	-0.03117
X61	0.15829	0.0311	-0.06217	-0.02985
X62	0.20996	0.09803	-0.02756	0.02783
X63	-0.11666	-0.08691	0.1516	0.45104
X64	-0.06131	-0.19557	0.35004	0.20843
X65	0.19935	-0.00193	0.10317	0.13776
X66	0.19569	-0.07143	0.05302	0.16926
X67	0.21792	0.02774	0.00751	0.24213
X68	-0.11935	-0.2788	0.10561	0.0661
X69	-0.02884	-0.18624	0.34627	0.3168
X70	0.1944	0.09357	0.05734	0.33375
X71	0.21167	-0.00528	0.01977	0.10072

Table S11. Principal component scores of quality-related traits for each treatment (X1–X40).

Index number	Composition			
	PC1	PC2	PC3	PC4
N0FP-1	-7.2112	-2.6520	0.6137	-2.2204
N0FP-2	-7.5547	-3.1121	0.4538	-1.7310
N0FP-3	-6.6670	-3.1498	-0.7203	-1.2781
N0LSF-1	-6.8339	-1.9357	-2.3983	-0.4323
N0LSF-2	-6.0910	-2.1561	-1.9643	-0.2318
N0LSF-3	-6.9454	-1.3410	-2.2923	-0.3289
N0PQSF-1	-6.8556	-0.7878	-0.0644	0.6348
N0PQSF-2	-6.2954	-0.0293	-0.4281	0.3724
N0PQSF-3	-6.1829	-0.0236	-0.0380	0.1422
N45FP-1	-2.4521	-1.9177	1.6759	2.2685
N45FP-2	-1.5104	-3.6633	0.8837	2.0647
N45FP-3	-1.3428	-2.5713	1.1182	2.1391
N45LSF-1	-3.8562	3.4593	-1.3640	0.6249

Index number	Composition			
	PC1	PC2	PC3	PC4
N45LSF-2	-3.3931	2.9548	-2.5803	1.4067
N45LSF-3	-3.4639	2.7194	-1.9854	1.3288
N45PQSF-1	-4.8897	2.4421	0.4863	-2.1165
N45PQSF-2	-6.0914	2.4918	0.3416	-2.3602
N45PQSF-3	-5.2559	2.5417	1.0018	-2.1785
N90FP-1	1.7353	-2.5133	1.3826	1.5478
N90FP-2	1.5922	-2.0244	-0.0557	2.0053
N90FP-3	1.5310	-1.9070	1.0986	0.1608
N90LSF-1	0.3240	3.4070	-0.6794	1.2063
N90LSF-2	-0.3030	3.3177	-0.4004	1.1135
N90LSF-3	0.5699	3.5645	-1.0808	0.8015
N90PQSF-1	-1.0418	0.6236	1.5867	1.3211
N90PQSF-2	-1.9312	1.4758	2.1256	0.6173
N90PQSF-3	-1.1289	0.8861	1.9666	1.4937
N135FP-1	4.8999	-1.2471	1.2652	-0.9641
N135FP-2	4.9280	-0.9973	0.1057	-0.2208
N135FP-3	4.5584	-2.0128	0.0887	-0.3733
N135LSF-1	4.2519	-0.1185	-1.2588	0.4959
N135LSF-2	4.3364	1.0744	-2.1414	0.1032
N135LSF-3	4.9501	0.3274	-1.8721	0.4423
N135PQSF-1	1.1999	0.6673	1.4644	0.3619
N135PQSF-2	0.8428	1.4867	2.1142	-0.2212
N135PQSF-3	1.5788	1.4846	1.7643	-0.9082
N180FP-1	7.9501	0.7937	-0.3191	-0.6899
N180FP-2	8.0040	0.4682	-0.0137	-0.6111
N180FP-3	8.4687	-0.1053	0.4145	-1.0753
N180LSF-1	7.3417	-0.9717	-1.6525	-0.6203
N180LSF-2	9.0847	-2.0482	-2.6447	-1.0587
N180LSF-3	8.9305	-1.7470	-2.1648	-0.7326
N180PQSF-1	3.2578	1.3390	1.8312	-0.8534
N180PQSF-2	3.3275	0.7337	2.4548	-0.9289
N180PQSF-3	3.6336	0.7732	1.8809	-0.5171

Table S12. Principal component scores of yield-related traits for each treatment (X41–X71).

Index number	Composition			
	PC1	PC2	PC3	PC4
N0FP-1	-6.4589	-0.8444	0.9777	-1.5379
N0FP-2	-6.7306	-0.7211	0.8309	-1.3732
N0FP-3	-6.2699	-1.0014	1.0121	-1.7107
N0LSF-1	-5.2839	-1.1154	0.6351	-0.5142
N0LSF-2	-6.0265	-0.7923	0.1511	-1.2978
N0LSF-3	-5.7638	-0.7610	0.1735	-1.2208
N0PQSF-1	-5.9450	-0.7906	-0.9739	-0.6157
N0PQSF-2	-5.3313	-0.8794	-0.2775	0.0536
N0PQSF-3	-5.7797	-0.9285	-0.5147	0.0799
N45FP-1	-3.4205	2.0705	2.9562	0.3701
N45FP-2	-3.7735	2.1478	3.1537	0.7972

Index number	Composition			
	PC1	PC2	PC3	PC4
N45FP-3	-3.5132	1.6743	3.4719	0.6023
N45LSF-1	-2.5669	1.3028	1.4291	1.5913
N45LSF-2	-2.6624	1.1037	1.5061	2.0992
N45LSF-3	-2.6531	1.3840	1.0577	1.2456
N45PQSF-1	-2.5434	-0.6709	-0.9039	0.5496
N45PQSF-2	-2.1705	-0.1002	-1.5588	0.2742
N45PQSF-3	-2.7946	-0.2972	-1.5381	-0.1182
N90FP-1	-1.4782	0.6777	-2.6233	2.8254
N90FP-2	-1.8544	0.9248	-3.1869	2.3402
N90FP-3	-1.4976	0.7483	-3.0540	2.4021
N90LSF-1	1.8628	-4.4348	-0.1390	2.2678
N90LSF-2	2.1846	-3.8835	-1.0704	1.7817
N90LSF-3	2.1345	-4.1326	-0.4069	1.9167
N90PQSF-1	2.4115	-4.1997	-0.6311	-1.9189
N90PQSF-2	2.8145	-3.7312	-1.3492	-2.1183
N90PQSF-3	3.0618	-3.8702	-0.9929	-1.5998
N135FP-1	3.5068	1.8615	0.3675	-1.8036
N135FP-2	3.6848	2.1128	0.1462	-2.1076
N135FP-3	3.3087	1.7669	0.9712	-1.8085
N135LSF-1	4.9625	0.7423	2.6094	0.9459
N135LSF-2	5.0937	0.7549	2.7985	0.9476
N135LSF-3	5.0918	0.9058	2.5049	1.0333
N135PQSF-1	1.4878	2.6153	-0.9424	-1.0028
N135PQSF-2	1.0257	2.3282	-0.4094	-0.7333
N135PQSF-3	1.5460	2.5644	-0.5828	-0.5707
N180FP-1	3.8973	2.1117	-2.3582	-0.2794
N180FP-2	3.9102	2.0027	-2.3207	-0.1561
N180FP-3	4.2123	2.0639	-2.3425	0.0456
N180LSF-1	6.9372	-1.7651	2.1189	-0.0535
N180LSF-2	6.4425	-2.0253	2.5913	0.4273
N180LSF-3	6.5245	-1.8853	2.5144	-0.1214
N180PQSF-1	2.8872	1.6953	-2.0808	-0.8556
N180PQSF-2	2.9594	1.9243	-2.3691	-0.9899
N180PQSF-3	2.5698	1.3462	-1.3507	-0.0889