

Table 1 Suppl. Pooled analysis of variance for various physiological traits of HD2808/HUW510 recombinant inbred line (RIL) population. DF – Degree of freedom, FoDAA - Initial fluorescence at anthesis, FmDAA - maximum fluorescence at anthesis, FvDAA - variable fluorescence at anthesis, Fv/FmDAA - photosynthetic efficiency at anthesis, Fo7DAA, Fm7DAA, Fv7DAA, and Fv/Fm7DAA - the same parameters 7 d after anthesis: Fo15DAA, Fm15DAA, Fv15DAA, and, Fv/Fm15DAA - the same parameters 15 d after anthesis CHCDAA, CHC7DAA, and CHC15DAA - chlorophyll content at anthesis, 7 d after anthesis, and 15 d after anthesis (** - significant at $P < 0.01$ and * - significant at $P < 0.05$).

Source	DF	FoDAA	FmDAA	FvDAA	Fv/FmDAA	Fo7DAA	Fm7DAA	Fv7DAA	Fv/Fm7DAA
Replications (R)	1	2524.9	35.2	0.037	0.00016	869.6	15743.6	9517	0.00005
Conditions (C)	1	16110.5**	13300.5*	31244.7**	0.04395**	1833.5**	135561.0**	111366.0**	0.02912**
Genotypes (G)	250	70.007**	2223.4	1660.02	0.00120**	94.6**	2588.9**	2101.8**	0.00135**
Year (Y)	1	75969.8**	33242.7**	275953**	2.00925**	236553.0**	127650.0**	17571.4**	2.07860**
G × C	250	72.27	1979.2	1364	0.00068**	82.0**	2134.7**	1581.6**	0.00075**
G × R	250	46.7**	1182.3**	675.1**	0.00003**	67.2**	1189.1	711.9**	0.00004**
G × Y	250	69.4	2398.1	1730.3**	0.00099**	115.5**	1729.7**	2171.7**	0.00098**
C × Y	1	37408.8**	975827**	522299**	0.00375**	3130.6**	54501.7**	29020.4**	0.00423**
Residual	502	113.4	2119.7	0.0014	0.00145	204.1	1977.7**	1340.8	0.00152

Source	DF	Fo15DAA	Fm15DAA	Fv15DAA	Fv/Fm15DAA	CHCDAA	CHC7DAA	CHC15DAA
Replications	1	1030.2	6958.5	2513.5	0.0037	7.5	0.1	18.3
Conditions	1	1030.2**	6958.5**	2513.5*	0.0037**	2048.5**	947.7**	585**
Genotypes	250	60.3**	2276.1**	1791.4**	0.0012**	14.7**	23.2**	28.6**
Year	1					154017.0**	156408.0**	
G × C	250	21.9	498.4	350.4**	0.0002	9.2**	12.7**	12.9**
G × R	250	21.9	498.4	350.5**	0.0002	1.2**	1.3**	1.88**
G × Y	250					14.5**	22.8**	
C × Y	1					656.2**	41.1*	
Residual	502	32.5	943.3	707.4	0.0004	83.7	87.5	1.81

Table 2 Suppl. Mean performance of various physiological traits for RILs and parents of wheat under timely sown (TS) and late sown (LS) conditions. For other abbreviations see Table 1 R = Reduction. Means ± SEs, $n = 6$.

Traits	HD2808			HUW510			RILs (mean)		
	TS	LS	R [%]	TS	LS	R [%]	TS	LS	R [%]
FoDAA	71.25±1.50	76.50±14.46	-7.37	70.50±9.11	68.95±5.01	2.19	69.30±5.04	75.00±3.20	-8.82
FmDAA	267.75±39.53	301.91±16.51	-12.76	307.75±73.62	254.29±33.96	17.37	276.29±23.80	271.18±21.98	1.15
FvDAA	196.22±38.27	221.24±7.31	-12.75	236.96±67.19	189.29±28.45	20.12	206.72±20.30	198.86±18.53	2.95
Fv/FmDAA	0.73±0.04	0.73±0.02	-0.63	0.76±0.04	0.74±0.04	2.57	0.74±0.01	0.73±0.02	1.24
Fo7DAA	71.50±9.98	75.25±17.84	-5.24	71.00±3.46	63.62±10.01	10.39	69.50±4.80	67.59±4.60	2.31
Fm7DAA	271.00±9.24	318.91±31.62	-17.68	356.50±16.74	255.50±26.96	28.33	293.17±26.05	276.82±22.01	4.88
Fv7DAA	199.37±12.43	243.48±13.91	-22.12	285.26±20.18	191.59±30.79	32.83	223.54±22.74	208.72±29.68	5.77
Fv/Fm7DAA	0.73±0.04	0.77±0.03	-4.11	0.80±0.02	0.75±0.05	6.57	0.76±0.01	0.75±0.02	0.97
Fo15DAA	52.50±4.95	42.50±9.19	19.04	45.83±7.30	57.67±9.42	-25.83	50.84±5.18	48.84±6.85	3.93
Fm15DAA	221.33±23.57	195.08±13.55	11.86	207.08±27.45	249.25±32.17	-20.36	233.75±29.43	228.49±38.23	2.25
Fv15DAA	168.72±18.53	152.66±4.18	9.51	161.03±20.36	191.43±22.64	-18.87	182.50±26.35	179.34±32.92	1.73
Fv/Fm15DAA	0.76±0.003	0.78±0.33	-2.88	0.78±0.005	0.77±0.008	1.15	0.78±0.023	0.78±0.023	-0.38
CHCDAA	31.25±9.11	31.80±12.02	-1.77	34.73±8.05	30.06±11.59	13.45	32.90±1.66	30.88±1.79	5.97
CHC7DAA	31.61±11.43	31.20±13.57	1.3	36.08±10.21	28.11±12.58	22.08	33.65±2.13	32.30±2.09	3.75
CHC15DAA	39.70±0.70	41.40±0.93	-4.28	42.16±0.236	40.68±0.26	3.37	41.58±3.32	40.05±3.38	3.67

Table 3 Suppl. Pooled heritability (Bs) for various physiological traits in HD2808 /HUW510 RIL population under timely sown (TS) and late sown (LS) conditions. For abbreviations see Table 1.

Traits	TS	LS
FoDAA	21.84	29.9
FmDAA	37.83	25.04
FvDAA	47.7	33.66
Fv/FmDAA	91.4	94.82
Fo7DAA	13.74	13.93
Fm7DAA	31.59	32.33
Fv7DAA	41.12	45.56
Fv/Fm7DAA	93.27	90.85
Fo15DAA	23.82	11.34
Fm15DAA	37.00	26.68
Fv15DAA	38.96	30.00
Fv/Fm15DAA	42.88	34.37
CHCDAA	80.73	80.69
CHC7DAA	88.56	85.71
CHC15DAA	83.36	85.50

Table 4 Suppl. Principal component analysis of various physiological traits in a HD2808/HUW510 RIL population. For abbreviations see Table 1. EV - Eigen value, CV - cumulative variance, PC - Principal component .

Traits	2013-14 Timely sown				Late sown				2014-15 Timely sown					Late sown				
	PC1	PC2	PC3	PC4	PC1	PC2	PC3	PC4	PC1	PC2	PC3	PC4	PC5	PC1	PC2	PC3	PC4	PC5
FoDAA	0.43	-0.17	-0.27	-0.27	0.21	-0.24	0.54	0.13	-0.06	0.21	-0.24	0.49	0.34	0.10	0.09	0.40	0.22	-0.45
FmDAA	0.53	-0.16	-0.11	-0.11	0.39	-0.42	0.11	-0.06	0.12	0.40	-0.34	0.26	-0.03	0.19	0.03	0.83	0.43	0.04
FvDAA	0.54	-0.16	-0.06	-0.05	0.39	-0.42	-0.01	-0.11	0.15	0.40	-0.33	0.19	-0.11	0.23	0.04	0.86	0.38	0.16
Fv/FmDAA	0.34	-0.05	0.25	0.26	0.31	-0.33	-0.33	-0.22	0.22	0.29	-0.20	-0.17	-0.42	0.26	0.04	0.36	-0.17	0.62
Fo7DAA	0.07	0.33	-0.62	0.41	0.22	0.25	0.55	0.09	-0.04	0.30	0.45	0.15	0.10	0.11	0.53	-0.42	0.49	0.24
Fm7DAA	0.14	0.57	-0.14	-0.01	0.39	0.41	0.13	-0.13	0.09	0.35	0.46	0.04	0.01	0.55	0.78	-0.21	0.19	-0.02
Fv7DAA	0.14	0.57	-0.02	-0.12	0.40	0.41	0.01	-0.17	0.11	0.35	0.45	0.01	-0.01	0.60	0.77	-0.15	0.11	-0.07
Fv/Fm7DAA	0.13	0.39	0.45	-0.49	0.30	0.28	-0.38	-0.27	0.27	0.15	0.09	-0.23	-0.18	0.58	0.41	0.19	-0.28	-0.27
Fo15DAA									0.19	-0.22	0.15	0.48	0.12	0.48	-0.37	-0.31	0.49	0.26
Fm15DAA									0.42	-0.25	0.09	0.29	-0.09	0.75	-0.51	-0.23	0.34	-0.01
Fv15DAA									0.44	-0.24	0.07	0.23	-0.13	0.77	-0.51	-0.20	0.29	-0.07
Fv/Fm15DAA									0.39	-0.10	-0.04	-0.10	-0.27	0.62	-0.33	0.03	-0.10	-0.38
CHCDAA	0.20	0.05	0.33	0.40	0.23	0.05	-0.13	0.69	0.31	0.09	-0.10	-0.23	0.29	0.48	-0.03	-0.03	-0.45	0.25
CHC7DAA	0.18	0.12	0.37	0.51	0.23	0.05	-0.32	0.57	0.25	0.09	-0.10	-0.29	0.52	0.57	-0.01	0.09	-0.62	0.05
CHC15DAA									0.33	-0.05	-0.01	-0.19	0.44	0.59	-0.08	0.13	-0.49	0.09
EV	3.17	2.83	1.29	1.02	3.67	2.34	1.45	1.18	3.51	3.37	2.68	1.58	1.11	3.85	2.44	2.22	2.04	1.04
Variance	31.17	28.29	12.90	10.17	36.71	23.43	14.51	11.78	23.36	22.49	17.86	10.56	7.42	25.64	16.24	14.77	13.58	6.93
CV [%]	31.71	60.00	72.91	80.09	36.71	60.14	74.66	86.44	23.37	45.86	63.73	74.29	81.71	25.64	41.88	56.65	70.23	77.17

Table 5A Suppl. Pooled correlation coefficient for various physiological traits under timely sown conditions in a HD2808/HUW510 RIL population. For abbreviations see Table 1. GMS - grain mass per main spike, GNS - grain numbers per main spike, TGM - 1000 grain mass, GY - grain yield, GFR - grain filling rate. (** - significant at $P < 0.01$ and * - significant at $P < 0.05$).

Traits	FoDAA	FoDAA	FoDAA	FoDAA	FoDAA	FoDAA	FoDAA	FoDAA	FoDAA	FoDAA
FoDAA	1									
FmDAA	0.753**	1								
FvDAA	0.634**	0.986**	1							
Fv/FmDAA	-0.072	0.573**	0.695**	1						
Fo7DAA	0.056	0.027	0.014	-0.02	1					
Fm7DAA	-0.033	0.063	0.08	0.121**	0.713**	1				
Fv7DAA	-0.046	0.068	0.09	0.145**	0.606**	0.989**	1			
Fv/Fm7DAA	-0.09	0.053	0.086	0.175**	-0.136*	0.555**	0.666**	1		
Fo15DAA	-0.072	-0.136*	-0.142*	-0.093	0.138*	-0.001	-0.032	-0.142*	1	
Fm15DAA	-0.167**	-0.134*	-0.115	0.014	0.049	0.027	0.019	0.011	0.708**	1
Fv15DAA	-0.176**	-0.126*	-0.103	0.034	0.029	0.032	0.029	0.041	0.602**	0.990**
Fv/Fm15DAA	-0.157*	-0.04	-0.006	0.122	-0.049	0.053	0.071	0.152*	-0.07	0.629**
CHCDAA	-0.035	0.139**	0.174**	0.243**	0.036	0.197**	0.213**	0.224**	-0.057	0.119
CHC7DAA	0.001	0.117*	0.138**	0.175**	0.05	0.209**	0.225**	0.238**	0.003	0.129*
CHC15DAA	-0.160*	-0.059	-0.031	0.094	0.003	0.105	0.119	0.170**	0.157*	0.363**
GMS	0.035	0.187**	0.216**	0.265**	0.059	0.124**	0.130**	0.146**	0.107	0.171**
GNS	0.055	0.190**	0.218*	0.260**	0.007	0.084	0.093	0.139*	0.044	0.088
TGM	0.145*	0.142*	0.132*	0.071	-0.005	0.034	0.044	0.105	0.04	-0.012
GY	0.004	0.216**	0.259**	0.342**	-0.051	0.160*	0.193**	0.286**	-0.003	0.043
GFR	-0.012	0.201**	0.244**	0.333**	-0.058	0.142*	0.173**	0.271**	0.021	0.065

Traits	Fv15DAA	Fv15DAA	Fv15DAA	Fv15DAA	Fv15DAA	GMS	GNS	TGM	GY	GFR
Fv15DAA	1									
Fv/Fm15DAA	0.728**	1								
CHCDAA	0.146*	0.239**	1							
CHC7DAA	0.145*	0.171**	0.327**	1						
CHC15DAA	0.380**	0.336**	0.286**	0.326**	1					
GMS	0.171**	0.144	0.230**	0.265**	0.138*	1				
GNS	0.089	0.064	0.162*	0.261**	0.1	0.659**	1			
TGM	-0.023	-0.047	0.075	0.104	0	0.545**	0.252**	1		
GY	0.047	0.07	0.269**	0.278**	0.084	0.750**	0.545**	0.437**	1	
GFR	0.067	0.071	0.263**	0.292**	0.093	0.742**	0.555**	0.421**	0.975**	1

Table 5B Suppl. Pooled correlation coefficient for various physiological traits under late sown conditions in a HD2808/HUW510 RIL population. For abbreviations see Table 1. GMS - grain mass per main spike, GNS - grain numbers per main spike, TGM - 1000 grain mass, GY - grain yield, GFR - grain filling rate (** - significant at $P < 0.01$ and * - significant at $P < 0.05$).

Traits	FoDAA	FmDAA	FvDAA	Fv/FmDAA	Fo7DAA	Fm7DAA	Fv7DAA	Fv/Fm7DAA	Fo15DAA	Fm15DAA
FoDAA	1									
FmDAA	0.440**	1								
FvDAA	0.359**	0.978**	1							
Fv/FmDAA	-0.072	0.374**	0.557**	1						
Fo7DAA	0.150**	0.054	0.007	-0.163**	1					
Fm7DAA	0.078	0.161**	0.165**	0.083	0.618**	1				
Fv7DAA	0.056	0.174**	0.190**	0.135**	0.458**	0.981**	1			
Fv/Fm7DAA	0.003	0.184**	0.228**	0.260**	-0.209**	0.619**	0.754**	1		
Fo15DAA	-0.057	0	0.014	0.056	0.055	0.029	0.02	-0.034	1	
Fm15DAA	-0.042	0.047	0.062	0.083	0.002	0.103	0.117	0.12	0.792**	1
Fv15DAA	-0.035	0.054	0.068	0.083	-0.006	0.116	0.133*	0.146*	0.709**	0.992**
Fv/Fm15DAA	0.026	0.095	0.098	0.062	-0.042	0.162**	0.196**	0.253**	-0.008	0.581**
CHCDAA	0.071	0.124**	0.162**	0.243**	0.08	0.187**	0.194**	0.174**	0.069	0.176**
CHC7DAA	0.056	0.120**	0.164**	0.257**	-0.012	0.208**	0.242**	0.293**	-0.04	0.116
CHC15DAA	0.07	0.134*	0.175**	0.254**	-0.082	0.141*	0.181**	0.253**	0.061	0.264**
GMS	0.103*	0.049	0.08	0.175**	-0.04	0.072	0.094	0.127**	0.066	0.165**
GNS	0.111	0.121	0.151*	0.207**	-0.026	0.168**	0.198**	0.229**	0.02	0.119
TGM	0.033	0.018	0.027	0.06	-0.029	-0.051	-0.049	-0.025	-0.129*	-0.013
GY	0.035	0.119	0.172**	0.301**	-0.118	0.099	0.14	0.240**	-0.03	0.033
GFR	0.012	0.122	0.168**	0.268**	-0.128*	0.059	0.098	0.203**	0.008	0.064

Traits	Fv15DAA	Fv/Fm15DAA	CHCDAA	CHC7DAA	CHC15DAA	GMS	GNS	TGM	GY	GFR
Fv15DAA	1									
Fv/Fm15DAA	0.676**	1								
CHCDAA	0.189**	0.190**	1							
CHC7DAA	0.141*	0.228**	0.490**	1						
CHC15DAA	0.291**	0.375**	0.389**	0.476**	1					
GMS	0.177**	0.206**	0.283**	0.191**	0.254**	1				
GNS	0.134*	0.193**	0.290*	0.240**	0.327**	0.722**	1			
TGM	0.011	0.160*	0.052	0.077	0.069	0.253**	0.082	1		
GY	0.042	0.087	0.262**	0.164**	0.186**	0.712**	0.541**	0.237**	1	
GFR	0.069	0.081	0.217**	0.139*	0.162**	0.695**	0.502**	0.222**	0.968**	1

Table 6 Suppl. QTLs for heat tolerance clustered in genomic regions of 1A, 2A, and 2D in literature. Fm - maximum fluorescence, Fv - variable fluorescence, Fv/Fm - photosynthetic efficiency, HSI – Heat Susceptibility Index, HSI-SKM - HSI-single kernel mass per main spike, HSI-KNM - HSI-kernel number, HSICT - HSI- canopy temperature, ShM: shoot dry mass, PH - plant height, CHL - chlorophyll content, HSI-GFD - HSI-grain filling duration, 75%G - 75 % green, 25%G - 25 % green, 50%G - 50 % green, MRS - maximum rate of senescence, TMRS - time to maximum rate of senescence, W - flag leaf glaucousnes, MAT - days to maturity, GY - grain yield, DTF - days to flowering, GFD - grain filling duration, TDS - temperature depression in main spike, FLL - flag leaf length, FLW - flag leaf width, DTH - days to heading; HI - harvest index, KDI - kernel diameter, KHA - kernel hardness, KMS - kernel mass per spike, SKM - single kernel mass, SD - spike density, CTD - canopy temperature depression, TGM - 1000 grain mass, HSI-GY: HSI-grain yield, TDL - temperature depression in flag leaf, AUSC - area under the SPAD curve, GMS - grain mass per spike; SGM - single grain mass, BY - biological yield, GNS - grain numbers per main spike.

References	1A	2A	2D
Mason <i>et al.</i> 2010 Vijayalakshmi <i>et al.</i> 2010	HSI-KNM, HSI-SKM	HSI-SKM, HSI-KNM, HSI-GFD 75%G, 25%G, 50%G, MRS, TMRS	DTF, GFD
Mason <i>et al.</i> 2011			HSI-SKM, DTF, MAT, TDS, FLL, FLW
Bennett <i>et al.</i> 2012 Tiwari <i>et al.</i> 2013 Mason <i>et al.</i> 2013	HSICT	W, MAT, GY	HSI-GFD DTH, MAT, HI, PH, KDI, KHA, KMS, SKM, TGM, GY, HSI-GY, CTD TDL
Mondal <i>et al.</i> 2015 Azam <i>et al.</i> 2016 Shirdelmoghanloo <i>et al.</i> 2016 QTLs in present investigation	Fm, Fv, Fv/Fm ShW, PH, CHL BY	Fv/Fm MAT, PH, BY, GY, HI, GFR, GWS, GNS,TGW, PH, MAT, DTH	ShW, CHL, AUSC, GMS, SGM DTH, DTF, GFD, HI, GFR, PH

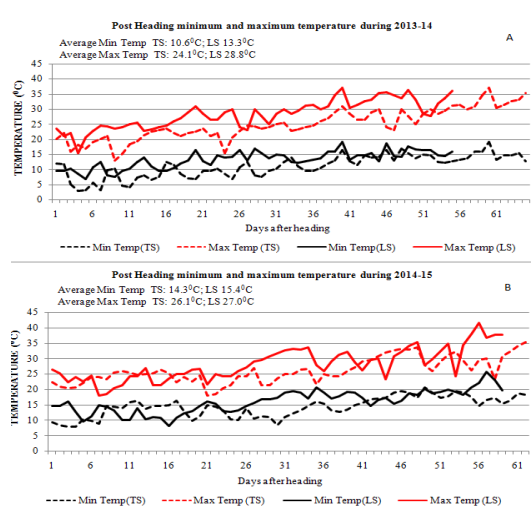


Fig. 1 Suppl. Post heading daily maximum and minimum temperatures under timely and late sown conditions: *A* - during crop season 2013 - 2014, *B* - during crop season 2014 - 2015.

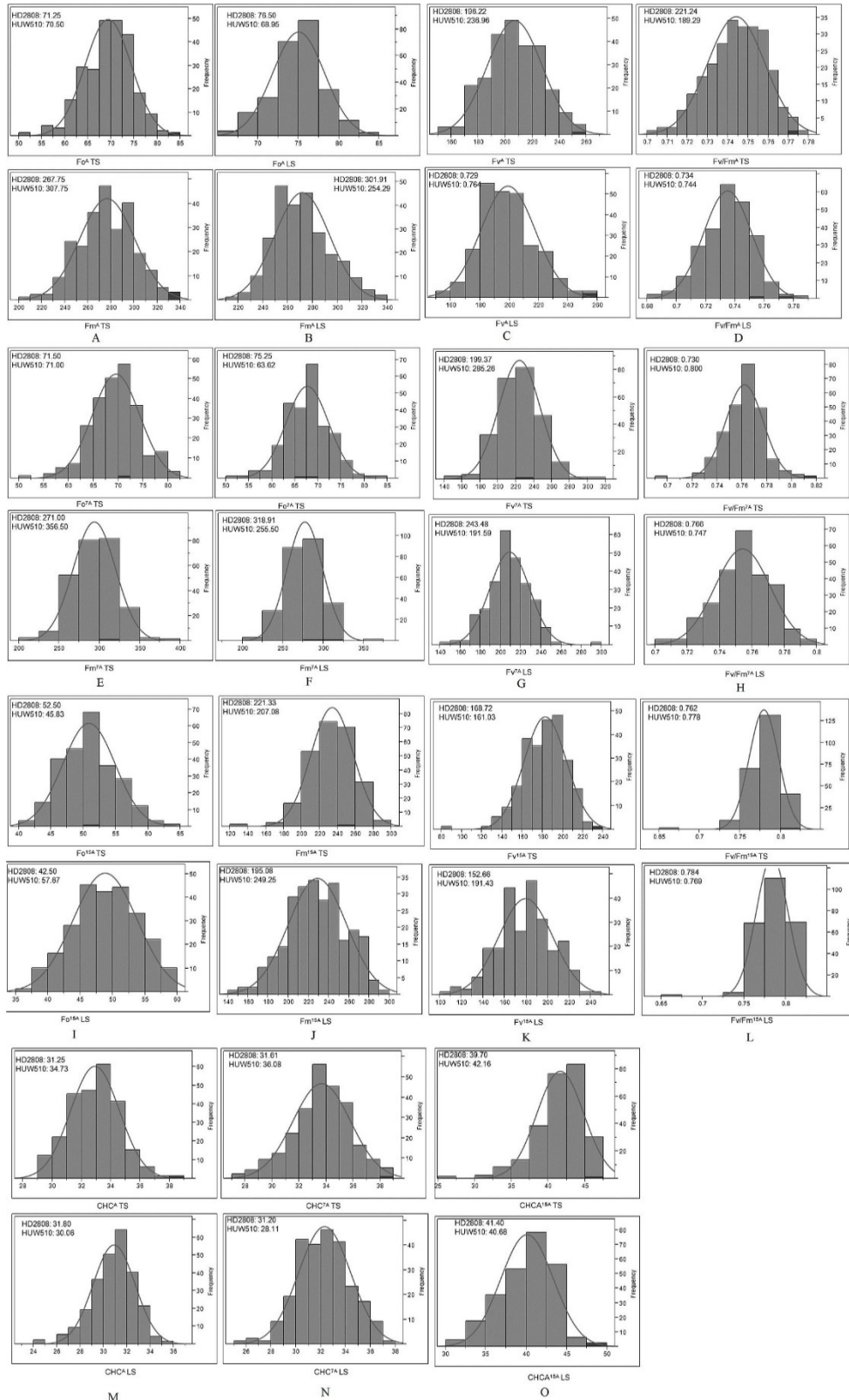


Fig. 2 Suppl. Frequency distribution of various physiological traits under timely sown (TS) and late sown (LS) conditions in HD2808 /HUW510 RIL population: *A* - Initial fluorescence at anthesis (Fo^A), *B* - maximum fluorescence at anthesis (Fm^A), *C* - variable fluorescence at anthesis (Fv^A), *D* - Fv/Fm^A at anthesis, *E* - Fo^{15DAA} , *F* - Fm^{15DAA} , *G* - Fv^{15DAA} , *H* - Fv/Fm^{15DAA} , *I* - Fo^{15DAA} , *J* - Fm^{15DAA} , *K* - Fv^{15DAA} , *L* - Fv/Fm^{15DAA} , *M* - Chl content at anthesis (CHC^A), *N* - CHC^{15DAA} , *O* - CHC^{15DAA} .

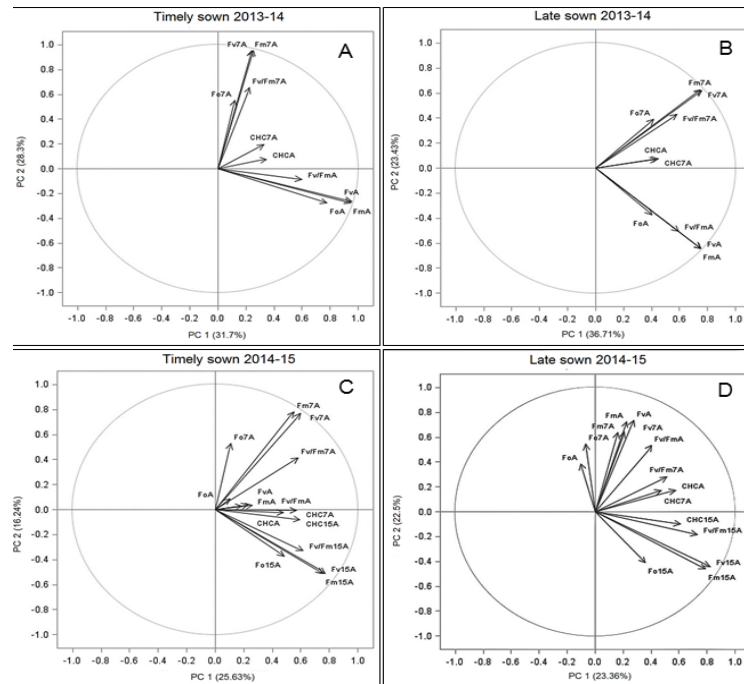


Fig. 3 Suppl. Biplot showing interrelationship among studied traits under timely sown and late sown (heat stress) conditions using HD2808/HUW510 RIL population.