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Supplementary Materials for

Chronoculture, harnessing the circadian clock to improve crop yield and sustainability

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Table S1. **Functions of circadian oscillator genes in crops.** Orthologues of Arabidopsis circadian clock genes in different crop species that have been identified as influencing flowering time, have conserved circadian function or both. Where applicable the commonly accepted names of relevant QTL have been included. Genes marked with an * are candidates that have been proposed to underlie a QTL effect but have not been definitively proven. LL refers to continuous light, DD refers to continuous darkness, SD refers to short day photoperiod and LD refers to long day photoperiod.

Arabidopsis Circadian Gene	**Crop**	**QTL/ Locus**	**Orthologue**	**Effects of allelic variation on flowering time**	**Other associated yield traits**	**Evidence of circadian function**	**Citation**
CCA1	*Brassica napus*		*BnaCCA1*		Height and seed yield		Schiessl S *et al.* (2015) *BMC Genomics* **16**:737
CCA1	rice		*OsLHY*			Overexpression of *OsLHY* in transgenic rise causes arrhythmia in DD	Ogiso E *et al.* (2010) *Plant Phys.* **152** pp. 808-820
CCA1	maize		*ZmCCA1*			Overexpression of *ZmCCA1a* in Arabidopsis causes arrhythmia in LL and causes a decrease of *AtTOC1* expression	Shi Y *et al* (2020) *Front. Plant. Sci* **11**:78 Wang X *et al.* (2011) *Plant Cell Rep.* **30**:1261-1272
CCA1	soybean		*GmLCL1/ GmLCL2*			Peak time of expression around dawn in both LD and SD, antiphase to *GmTOC1*	Liu H *et al.* (2009) *J. Plant Physiol.* **166**(3):278-89
ELF3	*T. Turgidum*		*TtELF3*	Premature stop codons in A and B sub-genome copies of *TtELF3* lead to early flowering independent of photoperiod			Alvarez MA *et al.* (2016) *Funct. Integr. Genomics* **16**: 365-382
ELF3	*T. monococcum*	*Eps-A^m1*	*TmELF3 **	Substitution of two amino acids predicted to reduce function cause early flowering	Spikelet number	Altered expression of *TOC1, PRR73* and *PRR59*	Alvarez MA *et al.* (2016) *Funct. Integr. Genomics* **16**: 365-382
ELF3	wheat	*Eps-D1*	*TaELF3-1D **	Sub-telomeric deletion of the 1D		Increased and delayed phase of *TaGI* expression in	Zikhali M *et al.* (2016) *J. Exp. Bot.*

				chromosome which includes *TaELF3-1D* causes early flowering		NILs carrying a *TaELF3-1D* deletion	**67**(1): 287-299
ELF3	barley	*eam8*	*HvELF3*	Gene deletion, predicted premature stop codons and a selection of point mutations that are predicted to reduce function cause early flowering		Loss of function mutation causes circadian arrhythmia in LL	Faure S *et al.* (2012) *PNAS* **109**(21): 8328-8333, Zakhrabekova S *et al.* (2012) *PNAS* **109**(11): 4326-4331
ELF3	pea	*HR*	*HR*	Predicted premature stop codon as a result of single base insertion mutation causes early flowering and reduced photoperiod sensitivity		Loss of function mutation causes circadian arrhythmia in LL but not DD	Weller J *et al.* (2012) *PNAS* **109**(51): 21158-21163
ELF3	lentil		*LcELF3*	Predicted premature stop codon causes early flowering and reduced photoperiod sensitivity			Weller J *et al.* (2012) *PNAS* **109**(51): 21158-21163
ELF3	rice	*Hd17*	*OsELF3*	Tos17 and T-DNA insertion into *OsELF3-1* delays flowering		Loss of function mutation causes circadian arrhythmia in LL but not DD	Zhao J *et al.* (2012) *PLOS ONE* **7**(8), Yang Y *et al.* (2013) *Mol. Plant* **6**(1): 202-215
ELF3	soybean	*J*	*GmELF3*	Indels and SNPs causing predicted premature stop codons and missense mutations delay flowering		Transcript abundance oscillates in LL, protein complexes with *GmELF4* and *GmLUX in vitro*	Lu S *et al.* (2017) *Nat. Gen.* **49**(5): 773-781
ELF4	pea	*DNE*	*DNE*	Predicted premature stop codon causes early flowering and reduced		Reduced rhythmicity in LL and DD, late phase *PsTOC1* expression in SD not LD	Liew LC *et al.* (2009) *The Plant Cell* **21**(10): 3198-3211

				photoperiod sensitivity			
GI	maize		*ZmGI1*	Insertion of *Mu* transposon into 5'-UTR and within coding region causes early flowering under long days			Bendix C *et al.* (2013) *Plant, Cell & Env.* **36**: 1379-1390
GI	rice		*OsGI*	Insertion of retrotransposon and 5-bp deletion within exon mutation causes late flowering under short days	Spikelet number, panicle number	Decreased amplitude of expression of cycling transcripts across entire transcriptome under diel conditions	Izawa T *et al.* (2011) *The Plant Cell* **23**(5): 1741-1755
GI	*B. rapa*	*PERIOD9a*	*BrGI*	Predicted premature stop codons introduced by TILLING are late flowering	Increased salt and freezing tolerance	Reduced rhythm robustness of leaf movement in LL	Xie Q *et al.* (2015) *PNAS* **112**(12): 3829-3834
GI	pea	*LATE1*	*LATE1*	Predicted premature stop codons cause late flowering		Loss function mutation causes circadian arrhythmia in LL and DD, reduced amplitude and late phase of *PsLHY, PsTOC1* and *PsELF4* transcript abundance	Hecht V *et al.* (2007) *Plant Phys.* **144**: 648-661, Liew LC *et al.* (2009) *The Plant Cell* **21**(10): 3198-3211
LUX	barley	*eam10*	*HvLUX*	Amino acid change within the highly conserved SHAQKYF motif causes early flowering independent of photoperiod		Loss of function mutation causes circadian arrhythmia in LL, down regulation of *HvCCA1* expression and up-regulation of *HvPRR1*, *HvGI* and *HvLUX* expression	Campoli C *et al.* (2013) *New Phyt.* **199**: 1045-1059
LUX	*T. monococcum*	*Eps-3A^m*	*TmLUX/WPCL 1 **	Deletion of *TmLUX* causes early flowering independent of photoperiod	Spike size, spikelet number	Loss of function mutation causes circadian arrhythmia in LL and down	Mizuno N *et al* (2012) *Genes Genet. Syst.* **87**:357-367,

						regulation of *TmLHY* expression	Gawronski P *et al.* (2014) *Genetics* **196**: 1253-1261
LUX	pea	*SN*	*SN*	Predicted premature stop codons, frameshift and missense mutations cause early flowering independent of photoperiod	Node of flower initiation	Loss of function mutation causes circadian arrhythmia in LL and down regulation of *PsLHY* expression	Liew LC *et al.* (2014) *The Plant Cell* **21**(10): 3198-3211
LUX	wheat		*TaLUX/WPCL 1*	Amino acid substitutions within the A and D sub-genome *TaLUX* MYB domains coupled with a 142 bp deletion at the start of *TaLUX-B1* causes early flowering		Altered expression of circadian clock and circadian output genes in the *LUX/WPCL1* null line Chogokuwase	Mizuno N *et al*. (2016) *PLOS ONE* **11**(10)
PRR3	soybean	*H6*	*GmPRR3b*	Predicted premature stop codon causes early flowering		Overexpressi on decreases *GmCCA1* expression, ChiP shows *GmPRR3b* binding to *GmCCA1* promoter	Li C *et al.* (2020) *Mol. Plant* **13**(5): 745-759
PRR3/PRR7	rice	*Hd2*	*OsPRR37*	Missense mutations within coding region cause early flowering			Koo B *et al.* (2013) *Mol. Plant* **6**(6): 1877-1888
PRR3/PRR7	wheat		*Ppd-1*	Deletions within *Ppd-1* promoters which increase expression cause early flowering independent of photoperiod. Truncation mutations delay flowering.			Shaw LM *et al.* (2012) *The Plant Journal* **71**: 71-84, Shaw LM *et al.* (2013) *PLOS ONE* **8**(11)
PRR3/PRR7	barley		*Ppd-H1*	Missense mutations in conserved CCT domain	Leaf size		Turner A *et al.* (2005) *Science* **310**: 1031-1035,

				case late flowering			Digel B *et al.* (2016) *Plant Phys.* **172**:405-415
PRR3/PRR7	sorghum	*Ma1*	*SbPRR37*	Premature stop codon causes early flowering under long days			Murphy RL *et al.* (2011) *PNAS* **108**(39): 16469-16474
TIC	*Brassica napus*		*BnaTIC*		Height and seed yield		Schiessl S *et al.* (2015) *BMC Genomics* **16**:737
TOC1	wheat		*TaPRR1*	Two conservative amino acid changes within exons are associated with greater geographical range of cultivation	Plant height and thousand grain weight		Sun H *et al.* (2020) *Front. In Plant Sci.* **11**(285)
TOC1	potato		*StTOC1*		Potato tuberisation		Morris WL *et al.* (2019) *J. Exp. Bot.* **70**(20): 5703-5714