



Figure S1. *TaCKX* GFM and *NAC2* expression profiles in 7 DAP spikes, seedling roots, and phenotypic traits in maternal parent, paternal parent, and their six F<sub>2</sub> progeny, from reciprocal crosses of D16 x KOH7 (C3) and KOH7 x D16 (C4); D19 x D16 (C5) and D16 x D19 (C6); D19 x KOH7 (C7) and KOH7 x D19 (C8). The data represent mean values with standard deviation. Black and red asterisks indicate statistical significance compared to the maternal parent or paternal parent respectively (\* 0.05>p≥0.01, \*\*0.01>p≥0.001, \*\*\* p<0.001) using the ANOVA test followed by the LSD post-hoc test (STATISTICA 10, StatSoft).

C1: S12B x S6C (M & F2; P & F2) C2: S6C x S12B (M & F2; P & F2)		CKX1 Spike	CKX2.1 Spike	CKX2.2 Spike	CKX5 Spike	CKX9 (10) Spike	CKX10 (9) Spike	CKX11 (3) Spike	NAC2- 5A Spike	CKX1 Root	CKX3 (6) Root	CKX5 Root	CKX8 (11) Root	CKX10 (9) Root	CKX11 (3) Root	NAC2- 5A Root	CKX activity Root	CKX activity Spike	Plant height	Spike number	Empty spike number	Semi- empty spike number	Grain number	Grain yield	Spike length	TGW	Root weight	
CKX1 Spike	C1 (M + F2)				0.73			0.63							-0.67			0.73					-0.61					
S12B x S6C	C1 (P + F2)			0.39				-0.12							-0.43			0.58					-0.25					
CKX1 Spike	C2 (M + F2)							0.16							-0.20			0.67			0.71							
S6C x S12B	C2 (P + F2)							0.68							-0.60			0.87			0.55							
CKX2.1 Spike	C1 (M + F2)			0.05														0.62		0.50						0.65		
S12B x S6C	C1 (P + F2)			0.60														0.33		0.67						0.33		
CKX2.1 Spike	C2 (M + F2)																											
S6C x S12B	C2 (P + F2)																											
CKX2.2.2 Spike	C1 (M + F2)																	0.37		0.65						-0.05		
S12B x S6C	C1 (P + F2)												0.60	0.64	0.87			0.61		0.74						0.69		
CKX2.2.2 Spike	C2 (M + F2)											0.63	0.56	0.74						0.73								
S6C x S12B	C2 (P + F2)																			0.14								
CKX5 Spike	C1 (M + F2)				0.50			0.68		-0.61	-0.33	0.29	0.22		-0.64	-0.37						0.62	-0.69				0.68	
S12B x S6C	C1 (P + F2)			0.76				0.80		-0.78	-0.61	0.66	0.63		0.01	-0.61						0.90	-0.32				0.38	
CKX5 Spike	C2 (M + F2)														-0.02													
S6C x S12B	C2 (P + F2)												-0.60															
CKX9 (10) Spike	C1 (M + F2)							0.38		-0.08												0.29						
S12B x S6C	C1 (P + F2)							0.72		-0.66												0.66						
CKX9 (10) Spike	C2 (M + F2)							0.60		-0.72												0.71			0.71			
S6C x S12B	C2 (P + F2)							0.49		-0.21												0.50			0.42			
CKX10 (9) Spike	C1 (M + F2)							0.75	0.83				0.61			-0.18										0.73		
S12B x S6C	C1 (P + F2)							0.75	0.59				0.69			-0.69										0.13		
CKX10 (9) Spike	C2 (M + F2)																											
S6C x S12B	C2 (P + F2)																											
CKX11 (3) Spike	C1 (M + F2)							0.79		-0.26			0.8															

C3: D16 x KOH7 (M & F2; P & F2) C4: KOH7 x D16 (M & F2; P & F2)	CKX1 Spike	CKX2.1 Spike	CKX2.2.2 Spike	CKX5 Spike	CKX9 (10) Spike	CKX10 (9) Spike	CKX11 (3) Spike	NAC2-5A Spike	CKX1 Root	CKX3 (6) Root	CKX5 Root	CKX8 (11) Root	CKX10 (9) Root	CKX11 (3) Root	NAC2-5A Root	CKX activity Root	CKX activity Spike	Plant height	Spike number	Empty spike number	Semi-empty spike number	Grain number	Grain yield	Spike length	TGW	Root weight
CKX1 Spike	C3 (M + F <sub>2</sub> )					0.44		0.78																		0.71
D16 x KOH7	C3 (P + F <sub>2</sub> )					0.64		0.41																		0.57
CKX1 Spike	C4 (M + F <sub>2</sub> )	0.76			0.74	0.87		-0.36	-0.70															0.66		
KOH7 x D16	C4 (P + F <sub>2</sub> )	0.55			0.32	0.52		0.71	-0.46															0.24		
CKX2.1 Spike	C3 (M + F <sub>2</sub> )		0.75	-0.73		0.33			-0.47	0.85		0.76					0.60					0.65	0.68	0.54		
D16 x KOH7	C3 (P + F <sub>2</sub> )		0.88	-0.59		0.66			-0.55	0.93		0.70		-0.68			0.38					0.59	0.47	0.63		
CKX2.1 Spike	C4 (M + F <sub>2</sub> )		0.71		0.86	0.83	-0.22		-0.58	0.68					-0.60											0.06
KOH7 x D16	C4 (P + F <sub>2</sub> )		0.63		0.66	0.59	-0.65		-0.57	0.59					-0.61											0.63
CKX2.2.2 Spike	C3 (M + F <sub>2</sub> )			-0.75		0.52			-0.44	0.60					-0.66							0.51	0.60	0.45		
D16 x KOH7	C3 (P + F <sub>2</sub> )			-0.53		0.88			-0.71	0.79					-0.69							0.60	0.50	0.64		
CKX2.2.2 Spike	C4 (M + F <sub>2</sub> )				0.78				-0.70	0.59		0.68	-0.53		-0.87			-0.32							-0.82	0.37
KOH7 x D16	C4 (P + F <sub>2</sub> )				0.59				-0.65	0.61		0.64	-0.61		-0.89			-0.71							-0.78	0.61
CKX5 Spike	C3 (M + F <sub>2</sub> )				0.75			0.59	-0.70				0.62	0.77												
D16 x KOH7	C3 (P + F <sub>2</sub> )				0.44			0.67	-0.48				0.42	0.64												
CKX5 Spike	C4 (M + F <sub>2</sub> )					0.48			-0.18		-0.37		-0.69													
KOH7 x D16	C4 (P + F <sub>2</sub> )					0.61			-0.65		-0.60		-0.16													
CKX9 (10) Spike	C3 (M + F <sub>2</sub> )														0.60						0.60					
D16 x KOH7	C3 (P + F <sub>2</sub> )														0.62						0.31					
CKX9 (10) Spike	C4 (M + F <sub>2</sub> )				0.73						-0.66				-0.55											
KOH7 x D16	C4 (P + F <sub>2</sub> )				0.19						-0.76				-0.62											
CKX10 (8) Spike	C3 (M + F <sub>2</sub> )								-0.25						0.68											
D16 x KOH7	C3 (P + F <sub>2</sub> )								-0.69						0.29											
CKX10 (8) Spike	C4 (M + F <sub>2</sub> )								-0.65	0.64		0.85												0.58		0.19
KOH7 x D16	C4 (P + F <sub>2</sub> )								0.20	0.47		0.67												-0.11		0.60
CKX11 (3) Spike	C3 (M + F <sub>2</sub> )										0.79	-0.75									-0.51					0.56
D16 x KOH7	C3 (P + F <sub>2</sub> )										0.74	-0.75										-0.64				0.70
CKX11 (3) Spike	C4 (M + F <sub>2</sub> )																									
KOH7 x D16	C4 (P + F <sub>2</sub> )																									
NAC2-5A Spike	C3 (M + F <sub>2</sub> )											-0.64			0.63											0.44
D16 x KOH7	C3 (P + F <sub>2</sub> )											-0.53			0.64											0.58
NAC2-5A Spike	C4 (M + F <sub>2</sub> )																									
KOH7 x D16	C4 (P + F <sub>2</sub> )																									
CKX1 Root	C3 (M + F <sub>2</sub> )								-0.37		-0.50		0.67									-0.30		-0.16		
D16 x KOH7	C3 (P + F <sub>2</sub> )								-0.76		-0.60		0.71									-0.63		-0.60		
CKX1 Root	C4 (M + F <sub>2</sub> )								-0.83		-0.53				0.66											
KOH7 x D16	C4 (P + F <sub>2</sub> )								-0.61		-0.60				0.65											
CKX3 (6) Root	C3 (M + F <sub>2</sub> )										0.67		-0.80				0.38					0.74	0.65	0.69		
D16 x KOH7	C3 (P + F <sub>2</sub> )										0.65		-0.76				0.62					0.85	0.73	0.89		
CKX3 (6) Root	C4 (M + F <sub>2</sub> )										-0.51				-0.66		0.70									0.69
KOH7 x D16	C4 (P + F <sub>2</sub> )										-0.61	0.90			-0.63		0.45									0.74
CKX5 Root	C3 (M + F <sub>2</sub> )																									0.72
D16 x KOH7	C3 (P + F <sub>2</sub> )																									0.75
CKX5 Root	C4 (M + F <sub>2</sub> )														0.63		-0.67			0.69						
KOH7 x D16	C4 (P + F <sub>2</sub> )														0.67		-0.49			0.68						
CKX8 (11) Root	C3 (M + F <sub>2</sub> )																			0.56		0.71	0.67			-0.41
D16 x KOH7	C3 (P + F <sub>2</sub> )																			0.66		0.65	0.60			-0.66
CKX8 (11) Root	C4 (M + F <sub>2</sub> )														-0.88		0.70					0.65				0.60
KOH7 x D16	C4 (P + F <sub>2</sub> )														-0.83		0.65									0.66
CKX10 (9) Root	C3 (M + F <sub>2</sub> )														0.60		-0.57									
D16 x KOH7	C3 (P + F <sub>2</sub> )														0.50		-0.66									
CKX10 (9) Root	C4 (M + F <sub>2</sub> )																									
KOH7 x D16	C4 (P + F <sub>2</sub> )																								0.72	0.67
CKX11 (3) Root	C3 (M + F <sub>2</sub> )																	-0.57				-0.65		-0.84		
D16 x KOH7	C3 (P + F <sub>2</sub> )																					-0.67		-0.84		
CKX11 (3) Root	C4 (M + F <sub>2</sub> )																									
KOH7 x D16	C4 (P + F <sub>2</sub> )																									
NAC2-5A Root	C3 (M + F <sub>2</sub> )																									
D16 x KOH7	C3 (P + F <sub>2</sub> )																									
NAC2-5A Root	C4 (M + F <sub>2</sub> )																								0.68	-0.63
KOH7 x D16	C4 (P + F <sub>2</sub> )																								0.60	-0.67
CKX activity Root	M + F2 P + F2																									
CKX activity Spike	M + F2																									
D16 x KOH7	P + F2																									
CKX activity Spike	M + F2																									
KOH7 x D16	P + F2																									-0.60 0.61
Plant height	M + F2																									-0.53 0.33
D16 x KOH7	P + F2																						0.61	0.32	0.60	0.59
Plant height	M + F2																						0.64	0.67	0.60	0.66
KOH7 x D16	P + F2																						0.67	0.64	0.64	
Spike number	M + F2																						0.57	0.62		0.44
D16 x KOH7	P + F2																						0.79	0.76		
Spike number	M + F2																						0.77	0.77		
KOH7 x D16	P + F2																						0.74	0.69	0.71	
Empty spike number	M + F2																						0.61	0.67	0.70	
D16 x KOH7	P + F2																									
Empty spike number	M + F2																									
KOH7 x D16	P + F2																									
Semi-empty spike number	M + F2																									
D16 x KOH7	P + F2																									-0.64
Semi-empty spike number	M + F2																									-0.47
KOH7 x D16	P + F2																									
Grain number	M + F2																									
D16 x KOH7	P + F2																						0.96	0.65	0.65	
Grain number	M + F2																									

C5: D19 x D16 (M & F2; P & F2) C6: D16 x D19 (M & F2; P & F2)	CKX1 Spike	CKX2.1 Spike	CKX2.2.2 Spike	CKX Spike	CKX9 (10) Spike	CKX10 (9) Spike	CKX11 (3) Spike	NAC2-5A Spike	CKX1 Root	CKX3 (6) Root	CKX5 Root	CKX8 (11) Root	CKX10 (9) Root	CKX11 (3) Root	NAC2-5A Root	CKX activity Root	CKX activity Spike	Plant height	Spike number	Empty spike number	Semi-empty spike number	Grain number	Grain yield	Spike length	TGW	Root weight
CKX1 Spike	C5 (M + F <sub>2</sub> )		-0.02						0.72	0.75		-0.73						-0.63				-0.70	-0.66			-0.03
D19 x D16	C5 (P + F <sub>2</sub> )		0.68						0.91	0.08		-0.54						-0.27				-0.02	-0.05			0.68
CKX1 Spike	C6 (M + F <sub>2</sub> )						0.36	0.75		-0.58					-0.70			-0.67		0.67			-0.36			0.71
D16 x D19	C6 (P + F <sub>2</sub> )						0.68	0.25		-0.84					-0.72			-0.46		0.50			-0.73			0.25
CKX2.1 Spike	C5 (M + F <sub>2</sub> )		0.70				-0.67														-0.11					-0.03
D19 x D16	C5 (P + F <sub>2</sub> )		0.91				-0.62														-0.64					0.68
CKX2.1 Spike	C6 (M + F <sub>2</sub> )		0.87																	0.39			0.58			0.71
D16 x D19	C6 (P + F <sub>2</sub> )		0.58																0.58				0.40			0.25
CKX2.2.2 Spike	C5 (M + F <sub>2</sub> )						-0.41						0.39													
D19 x D16	C5 (P + F <sub>2</sub> )						-0.57						0.65													
CKX2.2.2 Spike	C6 (M + F <sub>2</sub> )																									0.78
D16 x D19	C6 (P + F <sub>2</sub> )																									0.70
CKX5 Spike	C5 (M + F <sub>2</sub> )							0.68				-0.71	0.70	-0.91				-0.40								
D19 x D16	C5 (P + F <sub>2</sub> )							-0.04				-0.77	0.66	-0.87				-0.54								
CKX5 Spike	C6 (M + F <sub>2</sub> )						0.70	0.28			0.91								-0.71			0.62				
D16 x D19	C6 (P + F <sub>2</sub> )						0.35	0.77			0.82								-0.77			0.62				
CKX9 (10) Spike	C5 (M + F <sub>2</sub> )						0.12					-0.53														
D19 x D16	C5 (P + F <sub>2</sub> )						0.66					-0.64														
CKX9 (10) Spike	C6 (M + F <sub>2</sub> )									-0.61	0.74				-0.71											
D16 x D19	C6 (P + F <sub>2</sub> )									-0.71	0.78				-0.71											
CKX10 (9) Spike	C5 (M + F <sub>2</sub> )																									
D19 x D16	C5 (P + F <sub>2</sub> )						0.20													0.40						
CKX10 (9) Spike	C6 (M + F <sub>2</sub> )																			0.58						
D16 x D19	C6 (P + F <sub>2</sub> )						0.61													0.31						
CKX11 (3) Spike	C5 (M + F <sub>2</sub> )									-0.64		-0.31														
D19 x D16	C5 (P + F <sub>2</sub> )									-0.58		-0.66														
CKX11 (3) Spike	C6 (M + F <sub>2</sub> )											0.20														
D16 x D19	C6 (P + F <sub>2</sub> )											0.90														
NAC2-5A Spike	C5 (M + F <sub>2</sub> )								0.68	-0.65				-0.77												-0.60
D19 x D16	C5 (P + F <sub>2</sub> )								0.01	-0.59					0.04											0.30
NAC2-5A Spike	C6 (M + F <sub>2</sub> )																									
D16 x D19	C6 (P + F <sub>2</sub> )																			0.65						
CKX1 Root	C5 (M + F <sub>2</sub> )																		-0.61	-0.62						-0.65
D19 x D16	C5 (P + F <sub>2</sub> )																		-0.50	-0.66						-0.17
CKX1 Root	C6 (M + F <sub>2</sub> )												-0.77	-0.72												
D16 x D19	C6 (P + F <sub>2</sub> )												-0.52	-0.54												
CKX3 (6) Root	C5 (M + F <sub>2</sub> )														0.61											
D19 x D16	C5 (P + F <sub>2</sub> )														0.46							0.68	0.65			
CKX3 (6) Root	C6 (M + F <sub>2</sub> )														0.60							0.71	0.66			
D16 x D19	C6 (P + F <sub>2</sub> )														0.74											
CKX5 Root	C5 (M + F <sub>2</sub> )														0.66											
D19 x D16	C5 (P + F <sub>2</sub> )														0.48											
CKX5 Root	C6 (M + F <sub>2</sub> )										0.25	-0.62								0.62			0.73	0.67		
D16 x D19	C6 (P + F <sub>2</sub> )										0.85	-0.61							-0.79	0.58			0.35	0.38		
CKX8 (11) Root	C5 (M + F <sub>2</sub> )																									
D19 x D16	C5 (P + F <sub>2</sub> )												-0.64	0.66												
CKX8 (11) Root	C6 (M + F <sub>2</sub> )												-0.75	0.60												
D16 x D19	C6 (P + F <sub>2</sub> )																									
CKX10 (9) Root	C5 (M + F <sub>2</sub> )																									
D19 x D16	C5 (P + F <sub>2</sub> )														-0.72											
CKX10 (9) Root	C6 (M + F <sub>2</sub> )														-0.44											
D16 x D19	C6 (P + F <sub>2</sub> )														0.70											
CKX11 (3) Root	C5 (M + F <sub>2</sub> )																									
D19 x D16	C5 (P + F <sub>2</sub> )																		0.70							
CKX11 (3) Root	C6 (M + F <sub>2</sub> )																		0.83							0.63
D16 x D19	C6 (P + F <sub>2</sub> )																									0.01
NAC2-5A Root	C5 (M + F <sub>2</sub> )																									
D19 x D16	C5 (P + F <sub>2</sub> )																					0.75	0.79		0.57	
NAC2-5A Root	C6 (M + F <sub>2</sub> )																		0.64	0.56		0.53	0.66		0.60	
D16 x D19	C6 (P + F <sub>2</sub> )																		0.56							
CKX activity Root	M + F2																		0.62							
CKX activity Spike	M + F2																									
Plant height	M + F2																					0.68	0.65			
D19 x D16	P + F2																					0.56	0.56			
Plant height	M + F2																									
D16 x D19	P + F2																									
Spike number	M + F2																									
D19 x D16	P + F2																									
Spike number	M + F2																									
D16 x D19	P + F2																									
Empty spike number	M + F2																									
D19 x D16	P + F2																									
Empty spike number	M + F2																									
D16 x D19	P + F2																									
Semi-empty spike number	M + F2																									
D19 x D16	P + F2																									
Semi-empty spike number	M + F2																									
D16 x D19	P + F2																									
Grain number	M + F2																									
D19 x D16	P + F2																									
Grain number	M + F2																									
D16 x D19	P + F2																									
Grain yield	M + F2																									
D19 x D16	P + F2																									
Grain yield	M + F2																									
D16 x D19	P + F2																									
Spike length	M + F2																									
D19 x D16	P + F2																									

[illegible]

Table S2. Primer sequences designed for reference gene Ref 2, TaCKX GFMs and TaNAC2-5A

Ref 2	Ta2291R	NCBI	GCTTCTGCCTGTCACATACGC	165
	Ta2291F		GCTCTCCAACAACATTGCCAAC	
TaCKX1	TaCKX1_188R		CCCAGGTACTCCTTGTACCCTAT	188
	TaCKX1_188F		GTCTACCCGCTCAACAAATCC	
TaCKX2.1	TaCKX2_3_R_144		TCTCCTCGTTCTGCTCCTCC	144
	TaCKX2_3_F_144		TCTACCCCATGAACCGGGAC	
TaCKX2.2.1	TaCKX2_1_R_205		TATCACATACGCCATCCATGC	205
	TaCKX2_1_F_205		TTGATCGCGGAGCTAATCCA	
TaCKX2.2.2	TaCKX2_2_R_175		ATCGTATCCTGGCCTCCTCA	175
	TaCKX2_2_F_175		TACCCCATGAACCGGAACAG	
TaCKX3 (6)	TaCKX6_182R		CCGTGCTTGAATGTCTGC	182
	TaCKX6_182F		CACAAAGGAGGAGAAGGAGATG	
TaCKX4	TaCKX4_112_R		CTCCAAAGTCACACCCTCTACAC	112
	TaCKX4_112_F		AAGAACACGCAGCATAGCAAC	
TaCKX5	TaCKX5_3B_4R		CATACATGACACCAACGTACATCTT	150
	TaCKX5_3B_4F		GTCCGATTTTGTAGAAGACTGATT	
TaCKX8 (11)	TaCKX11_R_184		AGTCATGCACTGCAAACCTCTATG	184
	TaCKX11_F_184		GACCAAGAGCTTCTGATCTCAAT	
TaCKX9 (10)	TaCKX10_R_167		ACATAAAGCAATTTACCTGGACTTG	167
	TaCKX10_F_167		GAGCTAAGGGCTTGTGGGA	
TaCKX10 (9)	TaCKX9_R_278		GTCCCTGTTCATGGGGTACA	278
	TaCKX9_F_278		CCACGGTGGATCAGAAGCTC	
TaCKX11 (3)	TaCKX3_150R		GAATTAGAGTTCACGGCTTGATG	150
	TaCKX3_150F		TTGTCAAGGGACTGTAGTAGGG	
TaNAC2-5A	TaNAC2_R		GATGATGGAGCCCAAGGCGGAG	100
	TaNAC2_F		CTGGGTGCTCTGCCGGCTCTAC	