

Figure S5. The evolutionary tree was constructed using TBtool software.

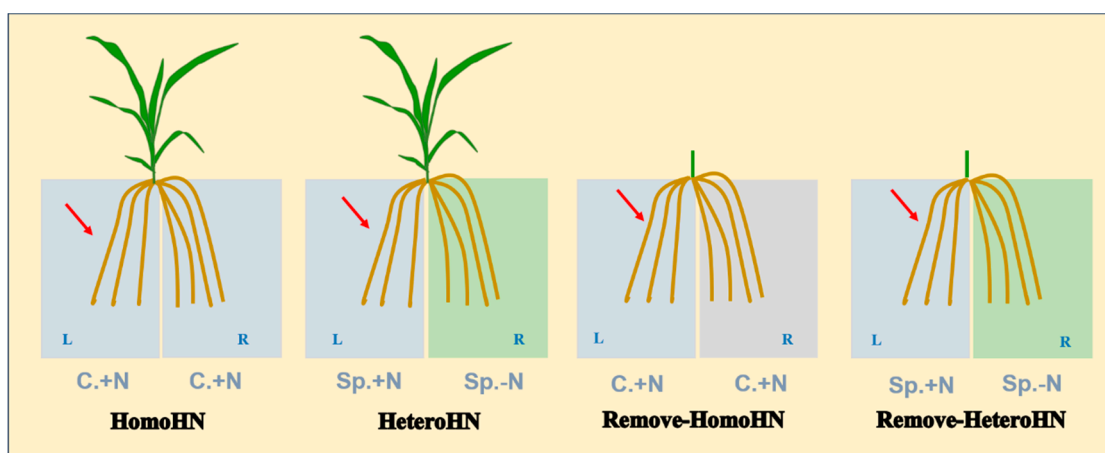


Figure S6. Split-root system in which the root system of a plant is separated into left (L) and right (R) parts that are exposed to different nutrient conditions. The red arrow points to the sampled tissue.

Table S1. Properties and predicted locations of ZmPP2C proteins.

Gene_name	Chr	Chr location	Ch ain	Numb er of amino	Instabi lity index	Theoretic al pI	Molecular weight (kDa)	Subcellular location
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acids								
ZmPP2C01	1	8216041- 8220640	+	357	45.9	7.7	39.95	Nucleus.
ZmPP2C02	1	8222270- 8226801	-	399	48.18	8.47	44.16	Nucleus.
ZmPP2C03	1	8237814- 8243635	+	399	48.16	8.69	44.07	Nucleus.
ZmPP2C04	1	39067264- 39069360	-	396	61.22	6.43	42.04	Nucleus.
ZmPP2C05	1	40463650- 40466683	+	740	51.38	7.62	81.28	Nucleus.
ZmPP2C06	1	45160373- 45162447	+	388	60.55	6.18	40.79	Nucleus.
ZmPP2C07	1	64567706- 64576354	+	962	51.43	6.04	106.3	Nucleus.
ZmPP2C08	1	69007071- 69011416	+	440	40.37	5.67	47.36	Nucleus.
ZmPP2C09	1	188239653 - 188244354	-	515	42.56	5.1	55.05	Nucleus.
ZmPP2C10	1	285863639 - 285867090	-	376	40.05	9.66	41.02	Nucleus.
ZmPP2C11	1	300484734 - 300488297	-	615	49.22	5.99	66.29	Chloroplast .
ZmPP2C12	1	302449509 - 302453159	-	379	37.54	6.83	41.05	Nucleus.
ZmPP2C13	2	4263315- 4267702	+	284	33.89	4.46	30.66	Nucleus.
ZmPP2C14	2	11409181- 11413754	+	315	40.17	8.66	34.16	Nucleus.
ZmPP2C15	2	15309005- 15312211	+	392	44.13	6.63	43.69	Chloroplast .
ZmPP2C16	2	46187668- 46192641	+	444	50.22	5.98	47.36	Nucleus.
ZmPP2C17	2	62682531- 62686631	+	521	44.28	4.62	57.48	Chloroplast .
ZmPP2C18	2	106146629 - 106150713	+	457	62.3	5.71	49.04	Nucleus.
ZmPP2C19	2	156948040	-	473	41.99	5	51.02	Chloroplast

		-						.
		156950830						
ZmPP2C20	2	165213344	-	581	52.69	6.65	63.72	Chloroplast
		-						.
		165220565						
ZmPP2C21	2	180274627	+	350	62	6.77	36.96	Nucleus.
		-						
		180276009						
ZmPP2C22	2	209737398	+	306	42.08	6.45	33.35	Nucleus.
		-						
		209739063						
ZmPP2C23	2	212637710	-	329	46.68	8.96	35.9	Cell membrane.
		-						
		212640699						
ZmPP2C24	2	217993093	+	146	44.13	4.64	16.26	Nucleus.
		-						
		217995851						
ZmPP2C25	2	220861770	-	454	47.05	4.82	47.5	Chloroplast
		-						.
		220866133						
ZmPP2C26	2	224728063	+	429	44.46	7.94	46.1	Nucleus.
		-						
		224731366						
ZmPP2C27	2	226054557	+	429	45.08	7.37	44.57	Chloroplast
		-						.
		226057199						
ZmPP2C28	3	75762675-	-	484	42.94	7.66	51.52	Nucleus.
		75779291						
ZmPP2C29	3	185093948	-	408	58.76	5.92	43.28	Nucleus.
		-						
		185095922						
ZmPP2C30	3	218456535	-	410	48.54	6.11	43.44	Nucleus.
		-						
		218462539						
ZmPP2C31	3	226455074	+	484	44.71	4.48	50.7	Chloroplast
		-						.
		226460821						
ZmPP2C32	3	232736476	+	384	39.44	5.29	41.19	Chloroplast
		-						.
		232740529						
ZmPP2C33	4	11862186-	+	436	50.66	6.71	45.46	Chloroplast
		11864645						.
ZmPP2C34	4	11872182-	+	106	26.24	7.03	11.07	Nucleus.
		11874449						

ZmPP2C35	4	104502063	-	458	38.13	6.66	49.97	Chloroplast
		-						.
		104516614						
ZmPP2C36	4	127220133	-	449	58.85	6.41	48.22	Nucleus.
		-						
		127245164						
ZmPP2C37	4	204429970	-	523	41.37	4.89	56.37	Nucleus.
		-						
		204434309						
ZmPP2C38	4	225770293	+	500	36.5	7.94	53.21	Chloroplast
		-						.
		225784317						
ZmPP2C39	4	228511195	-	1084	38.98	4.77	120.5	Cell
		-						membrane.
		228533871						
ZmPP2C40	4	232221731	+	357	38.35	5.97	38.55	Chloroplast
		-						.
		232231065						
ZmPP2C41	4	237957702	-	385	43.76	6.76	41	Nucleus.
		-						
		237960413						
ZmPP2C42	4	246114806	-	290	26.65	4.52	31.21	Nucleus.
		-						
		246118717						
ZmPP2C43	5	2629765-	+	632	51.5	5.4	68.21	Chloroplast
		2633632						.
ZmPP2C44	5	6892027-	+	367	44.89	9.69	40.09	Nucleus.
		6894932						
ZmPP2C45	5	39903133-	+	594	49.88	4.24	61.92	Nucleus.
		39909872						
ZmPP2C46	5	63655085-	-	394	49.15	8.88	43.8	Nucleus.
		63659727						
ZmPP2C47	5	82332663-	+	348	31.45	4.66	37.39	Chloroplast
		82336140						.
ZmPP2C48	5	93913340-	+	359	33.13	5.05	39.23	Nucleus.
		93920865						
ZmPP2C49	5	144347259	-	365	39.31	6.07	39.3	Chloroplast
		-						.
		144352230						
ZmPP2C50	5	157163131	-	385	44.68	6.76	41.17	Nucleus.
		-						
		157165949						
ZmPP2C51	5	163143385	-	526	37.45	7.11	55.8	Chloroplast
		-						.

		163148831							
ZmPP2C52	5	178759459	-	470	57.89	5.92	50.8	Nucleus.	
		-							
		178763854							
ZmPP2C53	5	191858823	-	322	36.08	7.94	34.33	Chloroplast	
		-						.	
		191861109							
ZmPP2C54	5	205611839	-	387	41.09	8.9	43.11	Chloroplast	
		-						.	
		205614878							
ZmPP2C55	5	206230718	+	550	51.69	5.73	62.08	Chloroplast	
		-						.	
		206241041							
ZmPP2C56	6	27476632-	-	431	44.19	7.44	45.09	Chloroplast	
		27483313						.	
ZmPP2C57	6	93300348-	+	390	50.55	9.04	43.15	Nucleus.	
		93306754							
ZmPP2C58	6	105423342	+	365	35.36	4.78	40.08	Nucleus.	
		-							
		105428237							
ZmPP2C59	6	149955406	+	419	49.46	8.89	45.53	Mitochondrion.	
		-							
		149959124							
ZmPP2C60	6	159266327	+	679	53.11	10.34	75.59	Chloroplast	
		-						.	
		159276528							
ZmPP2C61	6	173043093	-	370	39.53	5.08	39.72	Nucleus.	
		-							
		173047120							
ZmPP2C62	6	178866102	+	429	47	4.85	45.4	Chloroplast	
		-						.	
		178869300							
ZmPP2C63	6	179555644	+	499	51.48	4.48	54.31	Chloroplast	
		-						.	
		179563259							
ZmPP2C64	7	19919587-	+	583	51.52	7.43	63.74	Chloroplast	
		19933729						.	
ZmPP2C65	7	39226238-	+	239	39.97	6.36	25.82	Mitochondrion.	
		39227878							
ZmPP2C66	7	90311008-	-	360	39.03	7.03	39.03	Nucleus.	
		90325606							
ZmPP2C67	7	93421327-	+	358	53.91	6.82	37.6	Nucleus.	
		93422962							
ZmPP2C68	7	131676591	-	431	46.58	6.4	47.16	Chloroplast	

		-						.
		131681994						
ZmPP2C69	7	151898541	+	363	37.21	4.72	39.54	Nucleus.
		-						
		151904632						
ZmPP2C70	7	160529252	-	290	28.63	6.75	31.74	Nucleus.
		-						
		160538878						
ZmPP2C71	7	167218410	-	431	44.42	5.92	46.36	Chloroplast
		-						.
		167222438						
ZmPP2C72	7	179460272	-	352	38.57	4.78	37.24	Mitochondrion.
		-						
		179463998						
ZmPP2C73	7	183528521	+	429	41.95	7.6	46.03	Nucleus.
		-						
		183532791						
ZmPP2C74	8	60211518-	+	255	35.43	6.26	28.08	Nucleus.
		60221459						
ZmPP2C75	8	73727431-	-	159	43.23	4.44	16.94	Nucleus.
		73727910						
ZmPP2C76	8	73966393-	-	406	63.66	8.57	43.44	Nucleus.
		73969285						
ZmPP2C77	8	77866011-	-	505	47.96	4.42	55	Chloroplast
		77878684						.
ZmPP2C78	8	79568849-	+	423	44.71	4.84	44.9	Nucleus.
		79573001						
ZmPP2C79	8	137523807	-	508	47.15	6.33	54.39	Nucleus.
		-						
		137525931						
ZmPP2C80	8	139606577	+	391	37.54	5.53	41.77	Nucleus.
		-						
		139630785						
ZmPP2C81	8	142212025	+	473	39.87	8.79	50.38	Chloroplast
		-						.
		142217746						
ZmPP2C82	8	142405510	-	440	39.56	4.66	46.57	Chloroplast
		-						.
		142412923						
ZmPP2C83	8	148115539	+	375	45.85	7.29	40.48	Nucleus.
		-						
		148123566						
ZmPP2C84	8	151777850	+	394	60	6.61	41.71	Nucleus.
		-						

		151782663						
ZmPP2C85	8	175000529	-	413	52.84	6.76	43.82	Nucleus.
		-						
		175002418						
ZmPP2C86	9	109385970	-	365	34.61	4.67	40.21	Nucleus
		-						
		109391305						
ZmPP2C87	9	109598658	-	366	37.93	4.47	40.15	Nucleus.
		-						
		109603762						
ZmPP2C88	9	127296654	+	446	38.21	5.25	48	Nucleus.
		-						
		127301563						
ZmPP2C89	9	127653234	-	316	31.62	6.29	33.69	Chloroplast
		-						.
		127654184						
ZmPP2C90	9	132025472	+	393	45	8.48	43.6	Chloroplast
		-						.
		132029930						
ZmPP2C91	9	132988328	-	1008	47.09	6.02	111.16	Nucleus.
		-						
		132996488						
ZmPP2C92	9	142637006	+	430	38.07	6.95	45.92	Chloroplast
		-						.
		142640717						
ZmPP2C93	9	143668232	-	388	60.19	6.01	40.95	Chloroplast
		-						.
		143670483						
ZmPP2C94	9	153924323	-	391	49.92	7.93	42.15	Nucleus.
		-						
		153927090						
ZmPP2C95	9	155700197	-	596	36.94	4.07	61.39	Nucleus.
		-						
		155705998						
ZmPP2C96	9	158229333	+	399	44.13	8.69	44.15	Nucleus.
		-						
		158233704						
ZmPP2C97	10	66549934-	-	336	59.54	6.37	36.53	Nucleus.
		66564838						
ZmPP2C98	10	103573069	+	464	63.69	5.26	48.83	Chloroplast
		-						.
		103578268						
ZmPP2C99	10	115576486	-	521	43.55	4.66	57.18	Nucleus.
		-						

ZmPP2C10 0	10	115581534 123473400	-	443	49.44	5.98	47.54	Cell membrane.
		- 123478449						
ZmPP2C10 1	10	130813394	+	365	40.32	6.42	39.86	Nucleus.
		- 130818703						
ZmPP2C10 2	10	143862049	-	318	40.93	8.66	34.56	Nucleus.
		- 143866289						
ZmPP2C10 3	10	145825189	-	284	29.15	6.16	31.2	Nucleus.
		- 145837613						

Table S2. Estimates of the divergence style for maize's duplicated PP2C paralogs

Gene1	Gene2	Ka	Ks	Ka_Ks	Selection pressure
ZmPP2C05	ZmPP2C11	0.423919646	1.096443202	0.386631652	Purifying selection
ZmPP2C04	ZmPP2C29	0.302249727	0.806245259	0.374885587	Purifying selection
ZmPP2C09	ZmPP2C37	0.074529355	0.371648009	0.20053748	Purifying selection
ZmPP2C10	ZmPP2C44	0.038169012	0.277091725	0.137748653	Purifying selection
ZmPP2C11	ZmPP2C43	0.044313058	0.229026555	0.193484369	Purifying selection
ZmPP2C01	ZmPP2C46	0.174363156	2.135489862	0.081650191	Purifying selection
ZmPP2C04	ZmPP2C85	0.304972935	0.78456759	0.388714674	Purifying selection
ZmPP2C01	ZmPP2C96	0.027201814	0.18570984	0.146474815	Purifying selection
ZmPP2C08	ZmPP2C88	0.024936569	0.141858508	0.175784796	Purifying selection
ZmPP2C05	Zm00001eb397 680_T001	0.145729926	0.271879609	0.536009033	Purifying selection
ZmPP2C06	ZmPP2C93	0.034702102	0.288058781	0.120468822	Purifying selection
ZmPP2C07	ZmPP2C91	0.037790493	0.161115712	0.234554982	Purifying selection
ZmPP2C97	ZmPP2C14	0.142214563	1.381400977	0.102949517	Purifying selection

ZmPP2C102	ZmPP2C14	0.035989971	0.165081486	0.218013372	Purifying selection
ZmPP2C99	ZmPP2C17	0.019814263	0.151310838	0.130950717	Purifying selection
ZmPP2C100	ZmPP2C16	0.028716548	0.17558755	0.163545469	Purifying selection
ZmPP2C100	ZmPP2C36	0.201263243	1.10619562	0.181941818	Purifying selection
ZmPP2C100	ZmPP2C52	0.203224846	1.090057336	0.186435006	Purifying selection
ZmPP2C27	ZmPP2C33	0.091305647	0.269341099	0.33899634	Purifying selection
ZmPP2C16	ZmPP2C36	0.192169148	1.121249844	0.171388339	Purifying selection
ZmPP2C15	ZmPP2C54	0.149788736	0.937284477	0.159811391	Purifying selection
ZmPP2C16	ZmPP2C52	0.208102211	1.056224945	0.197024518	Purifying selection
Zm00001eb107120	ZmPP2C71	0.127211179	0.497846226	0.255523036	Purifying selection
ZmPP2C25	ZmPP2C72	0.069486265	0.260214915	0.267034137	Purifying selection
ZmPP2C26	ZmPP2C73	0.02001699	0.183831163	0.108887904	Purifying selection
ZmPP2C21	ZmPP2C67	0.058137202	0.20573101	0.282588424	Purifying selection
ZmPP2C20	ZmPP2C64	0.050940059	0.200919447	0.253534739	Purifying selection
ZmPP2C31	ZmPP2C61	0.290339744	1.364172008	0.21283221	Purifying selection
ZmPP2C29	ZmPP2C85	0.03762902	0.175694989	0.214172415	Purifying selection
ZmPP2C30	ZmPP2C76	0.254145745	0.729474364	0.348395719	Purifying selection
ZmPP2C30	ZmPP2C84	0.065456544	0.20849435	0.313948764	Purifying selection
ZmPP2C31	ZmPP2C82	0.032159823	0.185013593	0.173824112	Purifying selection
ZmPP2C36	ZmPP2C52	0.02653372	0.178502849	0.148645919	Purifying selection
Zm00001eb185410	ZmPP2C53	0.456261657	0.727032902	0.627566725	Purifying selection
ZmPP2C40	ZmPP2C49	0.027115185	0.221153838	0.122607798	Purifying selection

ZmPP2C41	ZmPP2C50	0.173175001	0.339671375	0.509831013	Purifying selection
ZmPP2C42	ZmPP2C47	0.022167219	0.189352473	0.117068546	Purifying selection
ZmPP2C40	ZmPP2C77	0.274283391	1.482834647	0.184972338	Purifying selection
ZmPP2C48	ZmPP2C58	0.118292946	1.039633759	0.113783287	Purifying selection
ZmPP2C46	ZmPP2C57	0.015385155	0.18509215	0.083121596	Purifying selection
ZmPP2C54	ZmPP2C90	0.3933866	2.639743615	0.149024548	Purifying selection
ZmPP2C55	ZmPP2C91	0.44617599	2.385674954	0.187022959	Purifying selection
ZmPP2C48	ZmPP2C86	0.116475057	0.947829191	0.122886126	Purifying selection
ZmPP2C62	ZmPP2C78	0.048739116	0.181881644	0.267971607	Purifying selection
ZmPP2C63	ZmPP2C77	0.061202395	0.226204474	0.270562265	Purifying selection
ZmPP2C61	ZmPP2C80	0.058141994	0.340544188	0.170732598	Purifying selection
ZmPP2C76	ZmPP2C84	0.253277957	0.789100001	0.320970671	Purifying selection
ZmPP2C77	ZmPP2C83	0.210999515	0.917678039	0.229927606	Purifying selection

Table S3. Functionally annotated cis-elements identified in the promoters of 13 *ZmPP2Cs*

Cis-Element	Functions of Cis-Elements	Number of Genes
ACA-motif	light responsiveness	6
ACE	light responsiveness	1
ATC-motif	light responsiveness	2
ATCT-motif	light responsiveness	19
Box 4	light responsiveness	10
G-box	light responsiveness	14
MRE	light responsiveness	66
Box II	light responsive	96
chs-CMA1a	light responsive	33
chs-CMA2a	light responsive	1
chs-CMA2b	light responsive	8
chs-CMA2c	light responsive	8
chs-Unit 1 m1	light responsive	1

GA-motif	light responsive	1
Gap-box	light responsive	5
GATA-motif	light responsive	15
GT1-motif	light responsive	1
I-box	light responsive	40
LAMP-element	light responsive	10
L-box	light responsive	42
3-AF1 binding site	light responsive	40
AAAC-motif	light responsive	10
Pc-CMA2a	light responsive	1
Pc-CMA2c	light responsive	2
Sp1	light responsive	78
TCCC-motif	light responsive	40
TCT-motif	light responsive	44
AT1-motif	light responsive	4
GTGGC-motif	light responsive	7
AE-box	light response	24
CAG-motif	light response	1
LTR	low-temperature responsiveness	53
MBS	drought-inducibility	58
TC-rich repeats	defense and stress responsiveness	31
WUN-motif	wound-responsive	21
GC-motif	anoxic specific inducibility	62
circadian	circadian control	9
MBSI	flavonoid biosynthetic genes regulation	8
O2-site	zein metabolism regulation	43
ARE	anaerobic induction	77
AACA_motif	endosperm-specific negative expression	1
CAT-box	meristem expression	61
HD-Zip 1	palisade mesophyll cells	7
motif I	root specific	4
MSA-like	cell cycle regulation	8
NON-box	meristem specific activation	1
RY-element	seed-specific regulation	11
AuxRE	auxin-responsive	1
AuxRR-core	auxin responsiveness	14
TGA-box	auxin-responsive	4
TGA-element	auxin-responsive element	56
TGACG-motif	MeJA-responsiveness	88
CGTCA-motif	MeJA-responsiveness	88
ABRE	abscisic acid responsiveness	98
GARE-motif	gibberellin-responsive	29
P-box	gibberellin-responsive	36
TATC-box	gibberellin-responsiveness	14

TCA-element	salicylic acid responsiveness	35
CCAAT-box	MYBHv1 binding site	57
Box III	protein binding site	4
HD-Zip 3	protein binding site	3

Table S4. The primers for qRT-PCR.

Gene name	Primer name	primer sequence (5'-3')	Product length (bp)
ZmPP2C19	RT-ZmPP2C19-F1	GCCTAAACCTGACGAAGATG	101
	RT-ZmPP2C19-R1	ACTTGTCGAAGGAATCCAAAT	
ZmPP2C37	RT-ZmPP2C37-F-3	CAGGGATTGGACCTTGTAAT	93
	RT-ZmPP2C37-R-3	GAGTTGCAGAGCAGTTAGAT	
ZmPP2C41	RT-ZmPP2C41-F-1	CAGGAACTGTCCTACCAATTAC	94
	RT-ZmPP2C41-R-1	GTGGTTGCTGTGCATTTATC	
ZmPP2C50	RT-ZmPP2C50-F-1	GAACGTGGTGTACGTGATG	156
	RT-ZmPP2C50-R-1	AATCCCTGGCAGAGTATGA	
ZmPP2C54	RT-ZmPP2C54-F-1	GACCTCAGGAAAGTTGAGAAG	101
	RT-ZmPP2C54-R-1	GTATCCCTCTCTTGCAAGTATC	
ZmPP2C69	RT-ZmPP2C69-F-1	TGCCAACCTCTCTCCATAAA	92
	RT-ZmPP2C69-R-1	CTTATCTCCCAGCTCAGTTAGT	
ZmPP2C71	RT-ZmPP2C71-F4	GCAGAACGGATCAAGAAGT	142
	RT-ZmPP2C71-R4	CATAATCCTTGAGGCAGAAGT	
ZmPP2C75	RT-ZmPP2C75-F-2	GTTCGAGACCATGGACAG	166
	RT-ZmPP2C75-R-2	CTTCAGGTAGCACGTCTC	
ZmPPC81	RT-ZmPP2C81-F-1	GAACACAGGGTTGAAGATACT	121
	RT-ZmPP2C81-R-1	GATCCCTGTCCATCACATAAA	
ZmPP2C85	RT-ZmPP2C85-F-1	CTGCGAAGAAGCCAAGTC	140
	RT-ZmPP2C85-R-1	GGAACCTCCTCATCTCCAA	
ZmEIF1	ZmEIF1-F	GCCGCCAAGAAGAAATGATGC	220
	ZmEIF1-R	CGCCAAAAGGAGAAATACAAG	