Supplementary Materials:

Table S1. Mating scheme used to form hybrids. The numbers within the table indicate the sets formed by mating inbred lines designated as females and males。.

	Males																			
Females	Inbred lines	1	2	3	4	5	6*	7*	8*	9*	10*	11*	12*	13*	14*	15*	16	17	18	19	20
	1						1	1	1	1	1	2	2	2	2	2	3	3	3	3	3
	2						1	1	1	1	1	2	2	2	2	2	3	3	3	3	3
	3						1	1	1	1	1	2	2	2	2	2	3	3	3	3	3
	4						1	1	1	1	1	2	2	2	2	2	3	3	3	3	3
	5						1	1	1	1	1	2	2	2	2	2	3	3	3	3	3
	6*											4	4	4	4	4	5	5	5	5	5
	7*											4	4	4	4	4	5	5	5	5	5
	8*											4	4	4	4	4	5	5	5	5	5
	9*											4	4	4	4	4	5	5	5	5	5
	10*											4	4	4	4	4	5	5	5	5	5
	11*																6	6	6	6	6
	12*																6	6	6	6	6
	13*																6	6	6	6	6
	14*																6	6	6	6	6
	15*																6	6	6	6	6

Inbred lines 1-5 were used as Females to form hybrids sets denoted with numbers 1, 2 and 3. Inbred lines with an asterisk (*) were used both as female and male to form hybrid sets denoted with numbers 1, 2, 5, and 5 and inbred lines 16-20 were used as males to form hybrids sets denoted with numbers 3, 5 and 6.

Table S2. Average kernel Zn concentration and grain yield for the hybrids in each environment.

Hybrid	Cross	Zn (mg/kg)					GY (t ha-1)					
		Tlaltizapan 2015	Tlaltizapan 2016	Agua Fria 2015	Cotaxtla 2015	Average	Tlaltizapan 2015	Tlaltizapan 2016	Agua Fria 2015	Cotaxtla 2015	Average	PH (cm)

1	1 x 6	26.85	30.10	31.34	24.22	28.72	6.20	6.34	2.88	2.31	4.11	221.43
2	1 x 7	27.15	26.77	27.42	23.08	26.24	6.59	5.53	2.45	3.12	4.19	233.72
3	1 x 8	26.10	29.13	26.80	26.33	27.35	8.09	5.96	4.27	2.58	5.07	240.11
4	1 x 9	24.18	27.86	23.36	27.00	25.79	6.00	5.95	3.01	3.55	4.48	239.11
5	1 x 10	24.00	32.05	26.47	27.18	27.59	10.51	9.31	6.86	4.63	7.88	244.50
6	2 x 6	22.31	28.61	29.62	25.17	26.47	4.52	4.77	2.88	2.53	3.32	220.15
7	2 x 7	26.40	28.62	25.93	27.78	27.71	5.12	5.80	4.12	3.34	4.38	217.93
8	2 x 8	22.04	27.15	29.04	28.43	26.83	5.99	6.16	4.94	3.55	4.96	221.72
9	2 x 9	23.96	29.72	27.04	24.53	26.55	10.88	9.92	7.18	5.40	8.40	249.65
10	2 x 10	22.04	30.30	26.59	25.74	26.28	9.44	10.04	6.79	5.95	8.21	244.32
11	3 x 6	23.88	32.53	28.51	-	28.28	5.82	4.65	2.36	1.77	3.23	234.88
12	3 x 7	21.48	27.99	29.91	28.67	27.24	6.48	6.83	4.07	2.63	4.78	233.83
13	3 x 8	24.30	27.95	28.75	28.36	27.76	7.73	6.63	4.49	3.53	5.38	252.38
14	3 x 9	23.58	27.69	29.60	24.69	26.42	9.21	9.29	7.25	6.03	8.04	251.40
15	3 x 10	22.46	29.25	21.46	25.93	24.78	10.40	9.22	6.74	5.01	7.95	249.86
16	4 x 6	20.50	29.49	-	25.39	25.49	6.51	6.10	2.18	1.95	3.80	207.27
17	4 x 7	22.87	27.30	25.38	24.57	25.06	6.42	5.38	3.22	2.77	4.15	236.72
18	4 x 8	23.51	28.62	26.18	22.22	25.02	6.51	6.63	4.32	4.40	5.37	234.82
19	4 x 9	23.47	23.19	26.88	25.67	24.96	8.76	8.76	4.50	6.45	7.20	241.07
20	4 x 10	24.94	27.93	30.24	25.21	27.22	9.35	8.99	6.41	3.76	7.16	247.15
21	5 x 6	27.83	31.50	26.43	-	28.66	3.84	4.72	1.79	1.37	2.48	219.89
22	5 x 7	23.47	23.74	25.79	26.59	25.08	4.47	4.63	3.29	2.70	3.40	232.61
23	5 x 8	26.06	32.25	25.42	29.16	28.62	5.95	5.60	4.60	2.91	4.62	234.88
24	5 x 9	23.02	24.16	24.85	26.86	24.75	10.72	9.43	6.23	6.12	8.29	246.77
25	5 x 10	23.28	29.81	25.22	24.99	25.94	10.24	10.98	6.32	5.30	8.30	247.95
26	1 x 11	23.09	27.63	26.55	21.56	24.56	10.04	9.78	7.57	4.16	7.91	245.03
27	1 x 12	21.74	23.83	20.91	22.73	22.11	9.88	10.37	7.71	6.14	8.68	255.45
28	1 x 13	24.26	29.36	26.80	27.08	27.11	9.19	9.17	7.34	4.80	7.63	251.83
29	1 x 14	23.58	23.80	24.72	23.54	23.95	9.25	9.40	6.42	5.67	7.85	257.39
30	1 x 15	21.25	24.18	21.94	21.60	22.01	9.10	8.90	7.15	3.92	7.25	245.62
31	2 x 11	23.81	27.84	27.17	22.96	25.45	9.78	9.64	7.97	5.13	8.24	239.67
32	2 x 12	23.77	29.29	27.09	21.21	25.36	9.91	10.06	7.84	6.39	8.64	250.60
33	2 x 13	25.09	30.89	28.00	24.44	27.27	9.97	10.32	8.87	6.27	9.05	251.78
34	2 x 14	24.90	25.30	23.83	24.25	24.61	9.08	8.42	7.51	6.39	7.89	250.06
35	2 x 15	21.03	26.61	25.14	26.39	24.78	10.10	8.79	8.36	5.36	8.23	243.40
36	3 x 11	22.98	25.15	23.02	21.49	22.98	9.25	11.02	6.42	4.83	7.88	251.43
37	3 x 12	23.17	26.81	20.99	21.94	23.13	10.48	9.57	7.19	5.79	8.28	262.69

38	3 x 13	22.76	25.80	25.70	20.64	23.54	9.16	10.77	7.71	5.98	8.52	254.00
39	3 x 14	20.99	22.68	20.99	23.59	21.69	8.45	7.84	6.92	4.39	6.80	235.73
40	3 x 15	20.43	21.86	23.85	21.88	21.59	9.92	9.32	8.16	4.52	7.96	253.98
41	4 x 11	23.43	28.66	25.78	21.50	24.88	9.12	9.05	7.44	4.57	7.45	243.24
42	4 x 12	22.46	25.59	22.53	22.92	23.20	9.21	9.24	7.64	5.72	7.97	251.45
43	4 x 13	24.60	30.16	25.82	26.74	26.95	8.87	10.73	8.55	6.89	8.90	252.31
44	4 x 14	19.03	26.05	22.57	22.65	22.31	11.15	9.19	6.64	7.06	8.64	247.15
45	4 x 15	21.29	24.27	22.65	22.08	22.28	9.09	9.48	7.57	5.60	7.96	245.40
46	5 x 11	21.85	29.51	23.27	20.73	23.70	8.79	8.93	6.97	5.93	7.71	249.27
47	5 x 12	24.26	26.61	21.57	23.06	23.80	7.64	9.46	7.88	5.07	7.53	251.75
48	5 x 13	27.64	25.07	27.26	NA	26.62	9.13	9.81	7.02	4.44	7.69	253.55
49	5 x 14	20.50	25.75	22.86	20.86	22.18	6.26	8.39	6.74	7.08	7.13	256.50
50	5 x 15	20.50	23.58	23.52	22.59	22.34	9.96	9.90	7.43	5.21	8.15	249.50
51	1 x 16	26.78	31.35	33.33	30.46	31.07	9.73	11.07	7.74	5.80	8.80	254.02
52	1 x 17	23.66	26.82	27.65	24.81	25.86	9.44	10.53	6.36	5.25	8.05	241.44
53	1 x 18	23.70	28.98	30.70	26.51	27.62	11.79	9.94	7.71	4.68	8.58	257.08
54	1 x 19	22.61	25.78	28.24	24.77	25.43	9.98	10.00	7.69	4.98	8.26	268.86
55	1 x 20	25.39	29.69	32.80	25.61	29.07	10.01	11.24	7.70	4.90	8.61	265.17
56	2 x 16	28.32	28.96	32.94	32.58	31.45	10.35	9.14	6.04	6.79	8.22	248.15
57	2 x 17	25.27	30.20	31.90	28.21	29.26	9.80	10.12	5.92	4.71	7.80	245.66
58	2 x 18	25.46	30.19	23.38	27.20	26.84	10.84	9.85	7.34	4.94	8.35	246.58
59	2 x 19	26.25	29.98	25.67	25.50	27.03	10.20	11.03	7.69	5.37	8.79	258.08
60	2 x 20	25.80	32.76	35.38	25.79	30.25	11.18	9.51	8.93	7.31	9.40	257.54
61	3 x 16	22.61	30.51	32.32	24.13	27.41	9.30	9.97	7.12	6.86	8.41	263.22
62	3 x 17	22.08	27.97	28.96	25.54	26.18	9.23	10.03	6.52	4.00	7.43	253.43
63	3 x 18	20.95	30.77	23.71	24.88	25.08	11.64	10.68	7.91	5.19	8.93	256.44
64	3 x 19	22.72	29.77	28.90	27.31	27.37	9.17	10.61	6.91	4.77	7.88	265.10
65	3 x 20	24.07	27.60	31.95	27.87	28.16	10.20	10.93	6.70	4.80	8.29	258.66
66	4 x 16	25.54	27.84	31.99	27.39	28.61	10.40	8.74	6.81	6.65	8.15	249.30
67	4 x 17	24.56	30.72	23.97	24.47	26.05	8.76	7.70	6.18	5.48	6.99	246.55
68	4 x 18	21.93	23.45	28.67	27.16	25.30	11.74	9.95	8.02	4.85	8.81	244.33
69	4 x 19	26.33	30.56	26.87	26.01	27.78	10.00	10.98	7.77	4.74	8.49	259.08
70	4 x 20	22.76	27.88	29.35	24.71	26.35	12.59	10.39	8.24	5.36	9.31	253.84
71	5 x 16	25.58	29.74	25.01	28.29	27.44	8.67	8.81	7.10	6.47	7.81	260.50
72	5 x 17	26.14	27.68	26.72	24.84	26.47	9.30	9.52	6.29	5.48	7.74	254.61
73	5x 18	23.55	28.46	26.26	27.35	26.57	11.03	9.16	8.40	5.78	8.63	248.96
74	5 x 19	24.49	30.25	29.37	21.66	26.72	11.74	9.39	7.62	5.52	8.64	261.34

75	5 x 20	25.35	29.26	29.39	25.73	27.64	11.15	10.37	7.00	5.61	8.71	260.47
76	6 x 11	21.10	26.29	24.39	21.99	23.27	7.54	7.50	5.66	3.63	5.99	250.18
77	6 x 12	20.05	23.67	21.61	23.93	21.99	10.41	11.08	6.47	4.32	8.21	252.85
78	6 x 13	21.14	25.45	21.59	24.28	22.81	9.37	9.89	6.81	4.16	7.55	253.55
79	6 x 14	19.00	23.57	21.24	20.43	20.73	7.28	9.47	5.92	5.04	6.94	253.10
80	6 x 15	18.92	24.34	22.53	21.24	21.35	10.05	8.64	5.98	5.69	7.61	248.55
81	7 x 11	22.79	25.25	22.40	21.29	22.71	8.76	7.93	5.72	3.73	6.53	244.32
82	7 x 12	21.55	22.65	21.61	19.71	21.05	8.28	8.60	6.69	5.43	7.33	246.66
83	7 x 13	20.76	25.02	22.91	24.12	23.03	7.71	8.58	6.63	5.20	7.02	249.43
84	7 x 14	18.85	20.49	20.53	20.01	19.61	7.59	6.52	5.96	4.54	6.01	255.58
85	7 x 15	18.47	20.79	19.04	19.45	18.93	7.40	7.22	6.85	3.83	6.27	243.20
86	8 x 11	21.24	23.32	24.32	21.80	22.41	10.81	9.77	7.83	5.89	8.66	250.69
87	8 x 12	20.84	24.18	22.77	23.27	22.51	9.64	9.14	7.30	4.18	7.66	252.71
88	8 x 13	23.58	27.66	25.14	24.69	25.32	9.03	10.08	7.45	6.03	8.32	248.97
89	8 x 14	21.67	23.14	23.19	23.97	22.70	9.94	7.79	6.88	6.32	7.77	259.71
90	8 x 15	20.09	22.70	20.31	22.29	20.88	9.29	7.93	7.71	6.07	7.74	255.09
91	9 x 11	18.88	21.91	24.43	22.67	21.58	5.55	6.69	4.47	4.30	5.08	241.00
92	9 x 12	18.92	25.10	21.61	23.41	21.94	8.53	8.39	4.21	4.74	6.44	247.45
93	9 x 13	22.12	28.68	26.22	26.78	26.00	9.92	9.29	7.58	5.95	8.28	255.31
94	9 x 14	18.55	22.04	20.71	22.14	20.56	5.14	6.06	3.80	3.28	4.47	233.39
95	9 x 15	18.06	20.43	20.04	21.32	19.54	7.37	7.55	4.36	5.20	6.12	241.68
96	10 x 11	21.48	25.06	25.51	21.65	23.27	7.46	8.59	5.60	4.93	6.61	234.05
97	10 x 12	17.98	24.33	22.15	24.10	21.67	5.27	6.49	3.01	1.91	3.84	211.85
98	10 x 13	21.44	30.12	24.14	22.95	24.60	8.73	9.20	5.29	5.50	7.33	236.42
99	10 x 14	20.69	21.73	21.53	22.02	21.17	6.19	10.57	7.02	7.19	7.83	250.59
100	10 x 15	21.97	23.06	19.58	22.69	21.43	6.08	8.27	5.52	4.94	6.15	244.89
101	6 x 16	23.77	26.30	29.33	26.13	26.46	9.72	8.27	6.30	4.88	7.36	252.71
102	6 x 17	20.73	25.52	23.98	24.48	23.51	8.95	9.05	6.65	4.37	7.31	256.27
103	6 x 18	22.61	30.35	24.35	26.53	26.15	10.65	10.92	8.16	4.57	8.68	254.31
104	6 x 19	23.77	26.60	24.15	24.54	24.82	11.39	10.40	6.38	5.36	8.54	259.14
105	6 x 20	24.15	28.10	26.24	26.83	26.50	10.09	9.31	8.55	5.68	8.55	260.23
106	7 x 16	24.60	27.32	26.22	27.38	26.70	8.63	8.74	6.52	5.74	7.51	252.11
107	7 x 17	20.24	24.41	24.35	23.76	23.01	7.18	7.11	4.98	3.60	5.64	241.83
108	7 x 18	20.46	27.51	26.88	25.92	25.15	9.16	8.74	6.72	6.59	7.87	246.68
109	7 x 19	20.88	26.19	25.14	26.37	24.64	8.12	8.57	5.76	5.32	7.02	246.67
110	7 x 20	22.76	27.08	30.17	23.03	25.92	9.50	9.87	6.89	5.20	7.91	255.11
111	8 x 16	25.43	29.75	28.21	22.01	26.47	10.40	10.32	7.55	6.18	8.81	257.01

112	8 x 17	23.88	25.83	24.60	27.40	25.73	9.49	10.21	5.97	5.02	7.65	248.35
113	8 x 18	22.31	23.81	28.17	28.51	25.76	12.05	10.29	5.60	4.48	8.23	248.03
114	8 x 19	24.71	28.22	25.35	22.58	25.32	11.39	9.14	6.53	5.78	8.28	255.14
115	8 x 20	23.47	27.29	28.96	NA	26.33	11.34	10.20	8.06	3.43	8.26	255.46
116	9 x 16	23.21	23.79	26.70	25.07	24.72	6.81	5.34	2.24	5.17	4.83	222.83
117	9 x 17	22.98	26.43	25.57	24.21	24.80	5.15	5.65	2.02	2.95	3.66	214.78
118	9 x 18	19.00	25.33	27.79	24.27	23.98	7.67	9.38	6.55	5.45	7.25	246.98
119	9 x 19	23.40	26.89	25.51	24.47	25.07	9.47	8.58	6.42	5.70	7.60	254.00
120	9 x 20	22.49	24.68	27.06	NA	24.51	8.84	9.76	6.70	6.78	8.18	258.09
121	10 x 16	23.24	29.25	25.01	23.06	25.14	9.58	8.11	3.83	4.19	6.48	235.82
122	10 x 17	19.11	30.05	26.07	22.56	24.27	8.19	8.54	4.38	4.79	6.42	239.08
123	10 x 18	24.57	32.77	26.80	22.92	27.01	4.79	3.85	1.39	3.48	3.20	214.44
124	10 x 19	20.50	24.15	27.71	29.79	25.49	6.34	4.23	1.08	1.53	2.92	217.64
125	10 x 20	24.41	28.76	31.74	25.27	27.79	4.33	3.56	1.20	1.90	2.33	235.39
126	11 x 16	24.18	28.56	27.42	25.32	26.73	9.10	6.72	5.80	4.51	6.50	257.92
127	11 x 17	20.91	26.58	28.17	23.12	24.59	7.16	8.59	6.27	4.54	6.55	251.34
128	11 x 18	18.47	25.29	22.90	21.90	21.79	9.53	9.78	6.46	4.07	7.46	244.28
129	11 x 19	20.73	25.36	23.85	22.87	22.99	8.87	8.18	7.00	5.89	7.52	256.53
130	11 x 20	21.82	26.08	24.93	23.52	23.98	9.38	8.77	6.70	5.35	7.58	261.80
131	12 x 16	22.15	24.97	24.81	25.11	24.29	8.05	9.36	5.81	4.16	6.82	253.03
132	12 x 17	20.65	23.03	22.88	25.19	22.73	5.41	7.48	4.80	3.95	5.17	246.43
133	12 x 18	19.67	22.42	20.41	22.41	20.91	8.97	6.47	3.71	3.57	5.54	240.54
134	12 x 19	18.88	21.64	20.87	22.39	20.43	7.37	7.89	3.94	3.12	5.40	245.97
135	12 x 20	20.39	25.01	24.56	23.36	23.15	7.67	7.40	4.67	4.27	6.03	253.81
136	13 x 17	24.15	25.89	25.26	26.47	25.57	7.59	9.75	6.82	5.78	7.56	248.90
137	13 x 18	20.99	25.39	27.55	24.72	24.54	10.57	9.53	8.01	6.13	8.65	247.21
138	13 x 19	22.34	27.56	24.48	22.88	24.25	9.06	7.81	7.03	4.85	7.08	258.31
139	13 x 20	22.49	27.80	27.75	25.67	25.98	10.14	9.77	6.49	6.72	8.48	259.18
140	14 x 16	20.84	22.37	28.13	25.86	24.02	7.47	6.62	4.46	3.02	5.16	231.42
141	14 x 17	20.43	21.76	23.02	24.33	22.19	6.76	7.60	4.22	3.48	5.36	247.49
142	14 x 18	19.19	22.38	20.70	20.74	20.37	8.64	8.89	5.66	4.22	6.79	257.80
143	14 x 19	20.31	21.71	22.07	21.24	20.99	8.38	7.49	4.35	5.07	6.29	256.44
144	14 x 20	18.92	22.68	24.68	23.94	22.08	9.05	8.54	5.81	4.62	7.07	256.46
145	15 x 16	18.81	23.58	20.74	20.98	20.76	8.43	7.28	7.21	6.19	7.33	250.07
146	15 x 18	18.13	22.35	22.75	21.63	20.87	9.24	8.64	7.64	7.16	8.28	253.26
147	15 x 19	22.23	22.86	21.40	20.96	21.60	8.26	7.79	6.66	5.03	7.01	258.31
148	15 x 20	19.56	23.46	22.57	23.79	22.00	8.98	8.49	5.31	5.05	7.04	258.48

149	ARTILLERO	17.83	22.17	21.74	21.43	20.34	9.25	6.31	6.15	6.50	7.09	235.70
150	SULTAN	19.07	20.52	25.67	19.94	20.59	9.61	6.31	5.17	5.21	6.55	228.12

Table S3. Phenotypic correlation between kernel Zn concentration and all agronomic traits.

Trait	Tlaltizapan 2015	Tlaltizapan 2016	Agua Fria 2015	Cotaxtla 2015	Across four environments
Grain yield	0.12	0.09	0.03	-0.09	0.02
Plant height	-0.04	-0.09	0.00	-0.14*	-0.01
Days to anthesis	0.20***	0.17**	0.17*	0.16*	-0.06
Anthesis silking interval	-0.03	0.05	0.05	-	0.03
Days to silking	0.19**	0.16**	0.17**	0.16*	-0.05

*, **, ***significant at $p < 0.05$,0.01 and 0.001 probability levels, respectively.

Table S4. Analysis of variance of combining abilities and their interactions for all traits.

Source of variation	df	Set1 Group A × Group B	Set2 Group A × Group C	Set3 Group A × Group D	Set4 Group B × Group C	Set5 Group B × Group D	Set6 Group C × Group D
Grain yield							
GCA_f	4	2.63	3.13	0.09	21.96**	85.95***	24.3***
GCA_m	4	128.34***	2.16	8.96	7.07*	4.13	2.97
SCA	16	6.47**	1.86	1.23	8.59***	15.1***	2.32*
Env	3	129.96**	135.53*	214.92**	120.65*	172.31*	105.88*
Env*GCA_m	12	1.42	3.85***	3.49***	1.84	1.70	3.27*
Env*GCA_f	12	1.44	2.29*	1.78	2.78	5.61**	0.94
Env*SCA	48	1.16	1.09	1.01	1.64	1.92*	1.22
Rep (Env)	3	5.00**	9.25**	6.50***	13.0***	11.52***	10.84***
Blk (Rep)	28	0.74	1.45	1.37	1.05	1.46	1.17
Residual Error	68	1.19	1.90	1.01	1.40	1.21	1.27
Zn concentration							
GCA_f	4	13.81	57.1***	28.65*	9.69	17.54	71.03***

GCA_m	4	22.86*	79.97**	57.23*	106.5***	27.49	34.26***
SCA	16	11.25	5.13	14.84	7.90*	7.39	4.88
Env	3	93.18	81.77*	149.57	65.17	146.33*	75.44*
Env*GCA_m	12	6.43	10.14	13.63	9.32*	9.20	2.89
Env*GCA_f	12	12.43	3.61	8.82	6.18	12.95	5.41
Env*SCA	45	13.81	7.45**	14.3**	3.85	11.38*	4.92*
Rep (Env)	3	12.47	2.65	4.65	10.41	6.56	6.85
Blk (Rep)	28	5.17	4.44	7.49	4.71	4.86	3.34
Residual Error	53	10.02	3.86	6.59	4.22	6.99	3.05
<u>Days to anthesis</u>							
GCAf	4	4.89*	4.06*	2.21	6.67*	3.52	28.17**
GCAm	4	13.24**	16.46*	3.88	19.88***	6.65**	1.82*
SCA	16	1.38	0.65	0.92	3.47***	4.14**	2.52
Env	3	1193.15***	1140.47***	1402.17***	1185.24***	1363.55**	1075.8***
Env*GCA_m	12	2.34	2.78*	2.77***	0.79	0.78	0.36
Env*GCA_f	12	1.20	0.81	1.53*	1.38	2.22	3.59**
Env*SCA	48	1.39	1.45	0.80	1.12	1.51	1.40
Rep (Env)	3	0.88	3.42*	6.12***	3.65*	3.65	3.30*
Blk (Rep)	28	0.85	1.05	0.92	0.81	1.36	0.72
Residual Error	68	0.97	1.22	0.92	1.22	1.59	1.04
<u>Anthesis silking interval</u>							
GCA_f	4	0.78	1.57	0.19	1.72*	0.39	2.06
GCA_m	4	0.94	2.97	3.84	3.30	1.60	1.27
SCA	16	1.65*	0.36	0.60	0.44	0.76	0.63
Env	3	3.70	5.63	5.81	4.55	4.98	7.98
Env*GCA_m	12	0.45	1.81***	2.02***	1.35**	1.76**	0.59
Env*GCA_f	12	1.02	0.80*	0.29	0.58	1.40*	0.81
Env*SCA	48	0.73	0.40	0.60	0.54	0.60	0.51
Rep (Env)	3	0.21	0.34	0.33	0.09	0.24	1.63*
Blk (Rep)	28	1.22	0.46	0.60	0.45	0.53	0.55
Residual Error	68	0.88	0.44	0.54	0.44	0.52	0.59
<u>Days to silking</u>							
GCA_f	4	7.13*	5.38*	2.27	5.32**	4.51	36.95**

GCA_m	4	15.82**	26.55*	9.32	32.02***	11.4**	5.11*
SCA	16	1.57	0.67	1.34	5.32***	6.17**	2.39
Env	3	1179.56***	1149.31***	1389.7***	1161.64***	1391.77***	1085.06***
$Env*GCA_m$	12	2.22	5.62***	4.03**	2.32	2.02	1.32
$Env*GCA_f$	12	1.99	1.03	1.81	0.82	5.06*	4.69**
Env*SCA	48	1.74	1.54	1.44	1.48	2.20	1.38
Rep (Env)	3	0.68	2.36	5.07**	3.61*	2.02	2.72
Blk (Rep)	28	1.06	1.27	1.22	0.98	1.79	1.26
Residual Error	68	1.70	1.56	1.07	1.22	1.82	1.18

*, ** and *** significant at $p < 0.05$, 0.01 and 0.001, respectively. GC_{Af} = the general combining ability effect of the lines designated as females; GCAm = the general combining ability effect of the lines designated as males. Group A, B, C and D = high Zn QPM, low Zn QPM, low Zn non-QPM and high Zn non-QPM, respectively.

Table S5. Specific combining ability for Zn among sets of hybrids evaluated in four environments.

Set1 (Group A x B)			**Set2 (Group A × C)**			**Set3 (Group A × D)**			**Set4 (Group B × C)**			**Set5 (Group B × D)**			**Set6 (Group C × D)**		
F	**M**	**SCA**	**F**	**M**	**SCA**	**F**	**M**	**SCA**	**F**	**M**	**SCA**	**F**	**M**	**SCA**	**F**	**M**	**SCA**
1	6	0.20	1	11	0.00	1	16	0.34	6	11	0.27	6	16	0.00	11	16	0.69
1	7	-0.04	1	12	0.00	1	17	-0.21	6	12	0.04	6	17	0.00	11	17	0.14
1	8	0.06	1	13	0.00	1	18	0.15	6	13	-0.57	6	18	0.00	11	18	-0.46
1	9	-0.06	1	14	0.00	1	19	-0.30	6	14	-0.11	6	19	0.00	11	19	-0.07
1	10	0.15	1	15	0.00	1	20	0.11	6	15	0.37	6	20	0.00	11	20	-0.16
2	6	-0.09	2	11	0.00	2	16	0.27	7	11	0.29	7	16	0.00	12	16	0.32
2	7	0.17	2	12	0.00	2	17	0.23	7	12	-0.07	7	17	0.00	12	17	-0.01
2	8	-0.01	2	13	0.00	2	18	-0.12	7	13	-0.24	7	18	0.00	12	18	-0.14
2	9	0.05	2	14	0.00	2	19	-0.16	7	14	-0.35	7	19	0.00	12	19	-0.47
2	10	-0.03	2	15	0.00	2	20	0.19	7	15	-0.43	7	20	0.00	12	20	0.21
3	6	0.16	3	11	0.00	3	16	-0.18	8	11	-0.25	8	16	0.00	13	17	0.01
3	7	0.11	3	12	0.00	3	17	-0.05	8	12	0.10	8	17	0.00	13	18	0.20
3	8	0.12	3	13	0.00	3	18	-0.17	8	13	0.30	8	18	0.00	13	19	-0.07
3	9	0.03	3	14	0.00	3	19	0.14	8	14	0.48	8	19	0.00	13	20	0.18
3	10	-0.25	3	15	0.00	3	20	0.08	8	15	-0.05	8	20	0.00	14	16	0.30
4	6	-0.14	4	11	0.00	4	16	0.03	9	11	-0.42	9	16	0.00	14	17	-0.03
4	7	-0.16	4	12	0.00	4	17	-0.07	9	12	0.08	9	17	0.00	14	18	-0.21
4	8	-0.24	4	13	0.00	4	18	-0.12	9	13	0.75	9	18	0.00	14	19	-0.08

4	9	-0.15	4	14	0.00	4	19	0.20	9	14	-0.15	9	19	0.00	14	20	-0.12
4	10	0.13	4	15	0.00	4	20	-0.22	9	15	-0.38	9	20	0.00	15	16	-0.89
5	6	0.21	5	11	0.00	5	16	-0.18	10	11	0.19	10	16	0.00	15	18	0.23
5	7	-0.19	5	12	0.00	5	17	-0.01	10	12	-0.19	10	17	0.00	15	19	0.42
5	8	0.25	5	13	0.00	5	18	0.07	10	13	0.08	10	18	0.00	15	20	0.03
5	9	-0.20	5	14	0.00	5	19	0.01	10	14	-0.02	10	19	0.00	-	-	-
5	10	-0.08	5	15	0.00	5	20	-0.02	10	15	0.26	10	20	0.00	-	-	-

Set1 = High-Zn QPM crossed to low-Zn QPM, Set2 = High-Zn QPM crossed to low-Zn non-QPM, Set3 =High-Zn QPM crossed to high-Zn non-QPM, Set4 =Low-Zn QPM crossed to low-Zn non-QPM, Set5 = High-Zn QPM crossed to high-Zn non-QPM and Set6 = Low-Zn non-QPM crossed to high-Zn non-QPM. F, M and SCA= Female, Male and Specific combining ability, respectively.

Table S6: General combining ability (GCA) effects for kernel Zn concentration at each environment

Inbred line	**Tlaltizapan 2015**			**Tlaltizapan 2016**			**Agua Fria 2015**			**Cotaxtla 2015**		
High Zn, QPM	**LZn, QPM**	**LZn, non-QPM**	**HZn, non-QPM**	**LZn, QPM**	**LZn, non-QPM**	**HZn, non-QPM**	**LZn, QPM**	**LZn, non-QPM**	**HZn, non-QPM**	**LZn, QPM**	**LZn, non-QPM**	**HZn, non-QPM**
1	1.28	0.00	-0.06	0.00	-0.45	-0.06	0.00	0.01	0.09	-0.20	0.14	0.00
2	-0.49	0.09	1.97*	0.00	1.47	0.13	0.00	1.88*	0.05	0.24	0.37	0.02
3	-0.65	-0.06	-2.24*	0.00	-1.52	0.03	0.00	-1.18	0.01	0.37	-0.42	-0.01
4	-0.71	-0.05	-0.29	0.00	0.61	-0.10	0.00	-0.27	-0.05	-0.79	0.17	0.00
5	0.57	0.02	0.61	0.00	-0.11	0.003	0.00	-0.44	-0.10	0.38	-0.27	-0.01
Low Zn, QPM	**HZn, QPM**	**LZn, non-QPM**	**HZn, non-QPM**	**HZn, QPM**	**LZn, non-QPM**	**HZn, non-QPM**	**HZn, QPM**	**LZn, non-QPM**	**HZn, non-QPM**	**HZn, QPM**	**LZn, non-QPM**	**HZn, non-QPM**
6	0.00	-0.24	0.19	1.73	0.23	0.19	0.00	-0.03	0.00	0.00	-0.13	0.00
7	0.00	0.06	-0.44	-1.57	-0.42	-0.34	0.00	-0.28	0.00	0.00	-0.86	0.00
8	0.00	0.70	0.68	0.46	0.06	-0.07	0.00	0.20	0.00	0.00	0.43	0.00
9	0.00	-0.72	-0.22	-1.91	-0.16	-1.00	0.00	0.06	0.00	0.00	0.48	0.00
10	0.00	0.20	-0.21	1.28	0.29	1.22	0.00	0.05	0.00	0.00	0.07	0.00

Low Zn, non-QPM	**HZn, QPM**	**LZn, QPM**	**HZn, non-QPM**	**HZn, QPM**	**LZn, QPM**	**HZn, non-QPM**	**HZn, QPM**	**LZn, QPM**	**HZn, non-QPM**	**HZn, QPM**	**LZn, QPM**	**HZn, non-QPM**
11	0.32	0.61	0.44	1.61	0.41	2.35	1.04	1.94	1.44	-0.78	-0.31	-0.62
12	0.37	-048	-0.42	0.21	-0.06	-1.08	-1.64	-0.45	-1.31	-0.28	0.07	0.17
13	2.31*	1.26	1.74*	2.18	3.69**	2.73*	2.67*	1.72	2.38*	1.06	1.10	2.38*
14	-1.01	-0.58	-0.83	-1.67	-2.11	-2.47*	-1.27	-1.01	-0.50	0.10	-0.09	-0.73
15	-1.99	-0.81	-0.94	-2.33	-1.94	-1.52	-0.81	-2.21*	-2.02	-0.09	-0.28	-1.19
High Zn, non-QPM	**HZn, QPM**	**LZn, QPM**	**LZn, non-QPM**	**HZn, QPM**	**LZn, QPM**	**LZn, non-QPM**	**HZn, QPM**	**LZn, QPM**	**LZn, non-QPM**	**HZn, QPM**	**LZn, QPM**	**LZn, non-QPM**
16	1.18	1.22	0.81	0.00	-0.66	0.52	1.80	0.41	1.04	1.57	0.00	1.10
17	-0.12	-1.12	0.45	0.00	-1.36	-0.17	-1.01	-1.66	0.30	-0.64	0.00	1.11
18	-1.24	-0.86	-1.24	0.00	2.45	-0.42	-2.12	0.19	-0.87	0.18	0.00	-1.28
19	0.00	0.01	0.10	0.00	-0.55	-0.28	-1.01	-1.01	-1.14	-0.90	0.00	-1.46
20	0.18	0.71	-0.12	0.00	0.72	0.37	2.35	2.06	0.67	-0.21	0.00	0.53

*, ** and *** Significant at p <0.05, 0.01 and 0.001, respectively. Lines from one group were mated in a modified design scheme to lines from three other groups so that three independent estimates of combining ability were computed for each line. LZn, QPM and LZn, non-QPM= low zinc QPM and non-QPM lines, respectively; HZn, QPM and HZn, non-QPM =high Zn QPM and non QPM lines, respectively.