

<https://doi.org/10.17221/154/2018-CJGPB>

Marker-trait associations of yield related traits in bread wheat (*Triticum aestivum* L.) under a semi-arid climate

SALEM MARZOUGUI¹, MOHAMED KHARRAT², MONGI BEN YOUNES¹

¹Pôle Régional de Recherche Développement Agricoles du Nord-Ouest semi-aride à El Kef, Institution de la Recherche et de l'Enseignement Supérieur Agricoles (IRESA), Tunisia

²Field crops Laboratory, INRAT, University of Carthage, Tunisia

Electronic Supplementary Material (ESM)

Table S1. The list of accessions evaluated in this study

Accession name	Improvement status	Origin	Group
65	landrace	Afghanistan	Adm
9	landrace	Afghanistan	2
Vilela Mar	cultivar	Argentina	Adm
Sel. 49–4807 H603	breeding material	Argentina	Adm
AB 21/1–1–1–2	breeding material	Australia	Adm
Aussie	cultivar	Australia	1
Kenora	cultivar	Australia	Adm
Picota 11	breeding material	Bolivia	Adm
Ofaie	cultivar	Brazil	Adm
CI 14371	breeding material	Brazil	Adm
S 493	breeding material	Canada	Adm
Manitou	cultivar	Canada	1
NR 2	breeding material	Canada	Adm
CItr 9548	landrace	China	Adm
CI 14204	breeding material	Colombia	1
CI 14246	breeding material	Colombia	Adm
CI 14387	breeding material	Ecuador	Adm
CI 14392	breeding material	Ecuador	Adm
Atacazo	cultivar	Ecuador	1
Napo	uncertain	Ecuador	1
ICARDA–IG–89788	breeding material	Egypt	Adm
1385–3331	breeding material	Egypt	Adm
Pusa Florence	uncertain	Egypt	Adm
1014	uncertain	Egypt	Adm
1360	uncertain	Egypt	Adm
CI 14812	landrace	Eritrea	Adm
CI 14821	landrace	Eritrea	Adm
56	landrace	Ethiopia	Adm
CI 14606	landrace	Ethiopia	Adm
Matte Lungo	landrace	Ethiopia	Adm
GAW 35–2	landrace	Ethiopia	Adm
IAR/W/128–5	landrace	Ethiopia	Adm
MG 31507	landrace	Ethiopia	Adm
Prinqual	cultivar	France	Adm
CItr 5478	landrace	Greece	Adm
Criollo	uncertain	Guatemala	Adm
CI4203	uncertain	Honduras	Adm
AUS 7301	landrace	India	2
AUS 7307	landrace	India	Adm
Gandumi Rishi	landrace	Iran	2
Gandum	landrace	Iran	2
MLP 68–12	landrace	Iran	Adm
IWA8602269	landrace	Iran	2
IWA8606195	landrace	Iran	Adm
IWA8606252	landrace	Iran	Adm

<https://doi.org/10.17221/154/2018-CJGPB>

Table S1 to be continued

Accession name	Improvement status	Origin	Group
IWA8608315	landrace	Iran	Adm
IWA8612186	landrace	Iran	1
Asosan	cultivar	Japan	Adm
Hiyoku Komugi	cultivar	Japan	Adm
Ishimskaja 100	cultivar	Kazakhstan	1
Equator KTI	cultivar	Kenya	Adm
559.L.2.C.1	breeding material	Kenya	Adm
Alkamu beri	uncertain	Mali	2
Koira alkuna	uncertain	Mali	2
CI 14282	breeding material	Mexico	1
CI 15834	breeding material	Mexico	Adm
CI 15850	breeding material	Mexico	Adm
II-1902	breeding material	Mexico	1
Mex 16	breeding material	Mexico	Adm
1018d	landrace	Morocco	Adm
Lalkazan	uncertain	Mozambique	2
Hasha	landrace	Nepal	Adm
Tiba	cultivar	Netherlands	1
Danbatta	uncertain	Nigeria	Adm
Gredha	landrace	Oman	Adm
Kule	landrace	Oman	2
7090	landrace	Oman	2
Musane	landrace	Oman	2
71-1	uncertain	Pakistan	2
NSGC 1227	landrace	Pakistan	Adm
Miriam	cultivar	Palestine	Adm
Yafo 539	cultivar	Palestine	Adm
Mescla	uncertain	Paraguay	Adm
3249	uncertain	Portugal	Adm
15007	uncertain	Saudi Arabia	Adm
15063	uncertain	Saudi Arabia	Adm
15085	uncertain	Saudi Arabia	Adm
Baladi	uncertain	Saudi Arabia	2
Maiah	landrace	Saudi Arabia	Adm
Gerbya	landrace	Saudi Arabia	2
NSGC 1373	uncertain	Saudi Arabia	2
CItr 4075	uncertain	Spain	Adm
CItr 6530	landrace	Spain	1
105	landrace	Sudan	Adm
123	landrace	Sudan	2
126	landrace	Sudan	2
Kaundouhari	landrace	Syria	Adm
Aleppo 21	landrace	Syria	Adm
CM 6943-5L-1L-OAP	breeding material	Syria	2

Table S1 to be continued

Accession name	Improvement status	Origin	Group
SE 381–4S–1S–6S–OS	breeding material	Syria	Adm
Liguleless	landrace	Tajikistan	2
3144–19	landrace	Tunisia	Adm
Frigui	landrace	Tunisia	Adm
Hmira	landrace	Tunisia	Adm
CI 15467	landrace	Tunisia	Adm
CI 15471	landrace	Tunisia	Adm
Arbi	landrace	Tunisia	Adm
Fritissa	landrace	Tunisia	1
CI 15517	landrace	Tunisia	1
Allorca	cultivar	Tunisia	Adm
Mahon	uncertain	Tunisia	Adm
Mahon 73	cultivar	Tunisia	Adm
Mahon 124	cultivar	Tunisia	Adm
Roussla	cultivar	Tunisia	1
3119	breeding material	Tunisia	1
Tunis 11	landrace	Tunisia	Adm
Tunis 23	landrace	Tunisia	Adm
2262–12	landrace	Tunisia	2
8328	landrace	Turkey	Adm
176/6	breeding material	Turkey	Adm
5348	landrace	Turkey	Adm
10446	landrace	Turkey	Adm
B–858	landrace	Turkey	Adm
CItr 3089	landrace	Turkmenistan	Adm
Guzlyk	landrace	Turkmenistan	2
Uruguay	uncertain	Uruguay	1
III–46–15	breeding material	USA	Adm
ND 407	breeding material	USA	1
II–60–115	breeding material	USA	1
II–62–71	breeding material	USA	1
ND 466–1	breeding material	USA	1
MT 8192	breeding material	USA	1
Turbat	landrace	Uzbekistan	2
357	landrace	Uzbekistan	2
4	uncertain	Venezuela	1
1076	uncertain	Yemen	Adm
Bohr Gamh	uncertain	Yemen	2
1138	uncertain	Yemen	Adm
1149	uncertain	Yemen	2

1, 2 – the cluster; Adm – the admixture

<https://doi.org/10.17221/154/2018-CJGPB>

Table S2. The summary results of the marker-trait associations (MTA) using the mixed linear model (MLM) with $-\log_{10}(P) \geq 3$ during the 2016/2017 cropping season

Traits	Markers	Chromosome	Position (cM)	P value	R ²
Awn length	IWA2504	1B	70 644	5.14E-04	0.18706
	IWA3125	1D	3 402	6.23E-04	0.32616
	IWA6734	2A	101 974	1.79E-04	0.1813
	IWA7510	3B	71 340	1.26E-05	0.28066
	IWA8179	3D	107 870	2.92E-04	0.18571
	IWA4854	4B	59 507	3.72E-04	0.1675
	IWA4313	5B	11 730	4.21E-05	0.28322
	IWA4127	5B	40 565	5.11E-05	0.5091
	IWA6550	6A	99 040	2.73E-04	0.19063
IWA1296	7D	134 399	1.87E-06	0.65902	
Flag leaf length	IWA8059	3D	148 409	1.92E-04	0.16748
	IWA5381	4D	80 677	1.68E-04	0.1681
Grain per spike	IWA4996	7A	134 176	4.44E-04	0.14263
Heading date	IWA4538	1A	101 642	9.26E-04	0.12587
	IWA2717	1B	81 609	6.97E-04	0.13287
	IWA692	2B	152 590	5.56E-04	0.13828
	IWA1383	3B	67 455	7.48E-05	0.18508
	IWA2864	4A	51 367	7.92E-06	0.24278
	IWA4041	4B	77 719	1.83E-04	0.16378
	IWA4767	5A	35 376	3.42E-04	0.15144
	IWA1486	5A	86 358	7.72E-04	0.13013
	IWA8386	6A	136 805	6.09E-04	0.13602
IWA2353	7B	68 835	3.87E-04	0.14566	
Internodes length	IWA3997	3B	68 870	4.79E-04	0.14041
	IWA4640	4B	73 860	6.54E-04	0.13212
	IWA7207	7B	89 825	1.99E-04	0.16279
Peduncle length	IWA7773	5A	53 465	9.63E-04	0.14003
Spike length	IWA4935	1B	146 254	4.70E-04	0.146
	IWA692	2B	152 590	8.81E-04	0.13129
	IWA1383	3B	67 455	2.46E-04	0.15978
	IWA4657	4A	51 367	5.28E-07	0.32154
	IWA3846	4B	71 914	1.43E-04	0.17226
Yield	IWA6937	6A	5 108	9.93E-04	0.12577
	IWA4	7B	67 473	7.17E-04	0.13901

<https://doi.org/10.17221/154/2018-CJGPB>Table S3. The summary results of the marker-trait associations (MTA) using the mixed linear model (MLM) with $-\log_{10}(P) \geq 3$ during the 2017/2018 cropping season

Traits	Markers	Chromosome	Position (cM)	<i>P</i> value	<i>R</i> ²
Awn length	IWA1883	1B	47 241	5.86E-4	0.15
	IWA3313	5A	56 485	3.85E-4	0.17
Flag leaf length	IWA8053	3B	85 517	8.46E-4	0.13
	IWA5381	4D	80 677	2.72E-4	0.15
	IWA5040	5A	92 869	7.65E-4	0.13
Grain per spike	IWA4810	3A	109 946	2.61E-5	0.21
	IWA3331	3B	85 517	5.61E-4	0.12
	IWA142	4A	48 524	1.57E-4	0.18
	IWA2353	7B	68 835	3.84E-4	0.15
Plant height	IWA6875	2B	97 264	4.84E-4	0.13
	IWA8386	6A	136 805	4.89E-4	0.13
Heading date	IWA4080	1A	96 305	9.49E-4	0.12
	IWA4385	2A	82 768	9.16E-4	0.12
	IWA1383	3B	67 455	3.87E-5	0.20
	IWA5335	4A	48 981	5.52E-5	0.19
	IWA3846	4B	71 914	7.89E-4	0.12
	IWA1486	5A	86 358	1.21E-4	0.17
	IWA52	6B	34 554	1.87E-4	0.16
	IWA2353	7B	68 835	9.70E-4	0.12
Internodes length	IWA4327	1A	71 096	4.16E-4	0.14
	IWA5708	2B	65 008	7.50E-4	0.13
	IWA1019	3A	88 017	5.35E-4	0.14
	IWA4685	3B	63 962	4.04E-4	0.15
	IWA483	4A	51 367	3.03E-4	0.15
	IWA4767	5A	35 376	2.64E-4	0.16
	IWA8386	6A	136 805	1.21E-4	0.18
	IWA6388	6A	35 330	9.10E-4	0.13
Spike length	IWA4838	3B	61 639	5.74E-4	0.13
Yield	IWA4511	1A	84 423	5.24E-6	0.50
	IWA4897	1A	137 205	2.82E-5	0.45
	IWA4141	1B	70 782	6.21E-5	0.209
	IWA1737	1D	87 358	2.96E-4	0.21
	IWA2537	2A	103 621	8.98E-4	0.16
	IWA1324	2B	134 650	1.26E-6	0.26
	IWA4284	2B	67 540	4.61E-5	0.23
	IWA2406	2D	39 688	5.52E-5	0.23
	IWA249	3A	88 017	1.93E-5	0.27
	IWA8290	3B	73 133	2.30E-6	0.28
	IWA1082	3D	104 575	1.56E-5	0.19
	IWA8432	4A	61 912	2.27E-7	0.29
	IWA4662	4B	46 861	1.12E-6	0.28
IWA3791	4D	83 844	2.27E-5	0.24	

<https://doi.org/10.17221/154/2018-CJGPB>

Table S3 to be continued

Traits	Markers	Chromosome	Position (cM)	<i>P</i> value	<i>R</i> ²
Yield	IWA2364	5A	73 971	3.40E-5	0.23
	IWA5412	5B	43 562	6.06E-5	0.27
	IWA6749	5D	67 492	1.114E-5	0.26
	IWA1497	6A	106 126	6.86E-5	0.20
	IWA1493	6B	375	1.82E-5	0.21
	IWA4592	6D	134 788	4.46E-5	0.19
	IWA5622	7A	135 807	5.56E-6	0.22
	IWA8233	7B	67 704	3.41E-5	0.21
	IWA118	7D	91 477	1.34E-5	0.18
	IWA431	7D	191 940	2.50E-4	0.18