



Supplemental Figure S1. Scan of the SSE collection of amaranth seeds used in this study.

Supplementary Table S1: Entry data for cultivated amaranth accessions from Seed Savers' Exchange (SSE) collection in Decorah, IA, USA.

SSE Amaranths Plant name			
SSE 1	R158	SSE 3	Mayo Indian
SSE 4	R1017	SSE 5	R1011
SSE 6	San Martin	SSE 7	Golden Giant
SSE 8	K112-R	SSE 10	Purple Giant
SSE 15	Oeshburg	SSE 22	Prince's Feather
SSE 24	Hopi Red Dye	SSE 29	Rodale 127
SSE 30	Rodale 124	SSE 31	Rodale 152
SSE 34	Rodale R125	SSE 35	Rodale R158
SSE 38	Rodale 156	SSE 39	<i>A. hypochondriacus</i>
SSE 40	<i>A. gangeticus</i>	SSE 42	Mexican
SSE 79	M. Dreadicus	SSE 80	<i>A. dedos</i>
SSE 86	Black Seed	SSE 92	Roter Meier
SSE 93	Roland	SSE 99	Paiute
SSE 104	Kerala Red	SSE 108	Tunisian
SSE 112	Jamaican Calalu	SSE 115	Kahlula
SSE 117	Polish	SSE 119	Black Leaved
SSE 132	Kellerman		

Supplementary Table S2: Passport data of Amaranth accessions from United States Department of Agriculture (USDA) collection in Ames, IA, USA.

No.	Accession	Species Origin Plant name
1	PI 553076	<i>A. australis</i> U.S., Florida Giant Amaranth
2	PI 166045	<i>A. caudatus</i> India Chua
3	PI 175039	<i>A. caudatus</i> India RRC 10
4	PI 490440	<i>A. caudatus</i> Peru LSK 19
5	PI 490477	<i>A. caudatus</i> Peru LSK 58
6	PI 490491	<i>A. caudatus</i> Argentina LSK 74
7	PI 490579	<i>A. caudatus</i> Bolivia LSK 355
8	PI 490603	<i>A. caudatus</i> Peru, Cajamarca LSK 398
9	PI 490604	<i>A. caudatus</i> Bolivia, Chuquisaca HH 50
10	PI 490607	<i>A. caudatus</i> Bolivia, Chuquisaca HH 54
11	PI 490609	<i>A. caudatus</i> Ecuador, Azuay HH 66
12	PI 511679	<i>A. caudatus</i> Argentina RRC 551
13	PI 511681	<i>A. caudatus</i> Bolivia Coimi
14	PI 511685	<i>A. caudatus</i> Peru HH 19
15	PI 511687	<i>A. caudatus</i> Peru HH 21
16	PI 511688	<i>A. caudatus</i> Peru Achita
17	PI 511689	<i>A. caudatus</i> Peru Achita
18	PI 511691	<i>A. caudatus</i> Peru Achita
19	PI 511693	<i>A. caudatus</i> Peru Achita
20	PI 511694	<i>A. caudatus</i> Peru RRC 572
21	PI 511698	<i>A. caudatus</i> Peru HH 37
22	PI 511700	<i>A. caudatus</i> Peru Achis, jonjoli
23	PI 511701	<i>A. caudatus</i> Peru Achis, jonjoli

24	PI 511703	A. caudatus Peru Coyo
25	PI 511704	A. caudatus Peru, Cajamarca Coyo
26	PI 553073	A. caudatus U.S., New Jersey Love-lies-bleeding
27	PI 568132	A. caudatus Bolivia, Tarjia coime
28	PI 568147	A. caudatus Bolivia, Tarjia coime
29	PI 608019	A. caudatus Ecuador, Pichincha HH 75
30	PI 634914	A. caudatus Pakistan, Azad Kashmir RRC 1395
31	PI 642736	A. caudatus U.S., California RRC 379
32	PI 642741	A. caudatus Bolivia Cscar Blanco
33	PI 649224	A. caudatus Peru, Ancash RRC 899
34	PI 669838	A. caudatus Bolivia RRC 556
35	Ames 30932	A. caudatus Russian Federation Red Utopia
36	Ames 31991	A. cruentus U.S., California Burgundy Amaranth
37	PI 288278	A. cruentus India RRS 31
38	PI 433228	A. cruentus Guatemala, Chimaltenango 2
39	PI 451711	A. cruentus Mexico GN 1144
40	PI 451825	A. cruentus Guatemala, Chimaltenango Cr045
41	PI 462371	A. cruentus Sudan CN110
42	PI 477912	A. cruentus Mexico RRC 416
43	PI 477913	A. cruentus Mexico RRC 1011
44	44 PI 477914	A. cruentus Mexico RRC 1041
45	45 PI 482049	A. cruentus Zimbabwe TGR 542
46	46 PI 482051	A. cruentus Zimbabwe TGR 603
47	47 PI 490655	A. cruentus Peru RRC 1121
48	PI 490662	A. cruentus Benin RRC 1034
49	PI 494771	A. cruentus Zambia ZFA 3330
50	PI 494777	A. cruentus Zambia ZFA 3653
51	PI 500264	A. cruentus Zambia ZM 2255
52	PI 500267	A. cruentus Zambia ZM 2309
53	PI 511715	A. cruentus Guatemala RRC 618
54	PI 511717	A. cruentus Guatemala HH 85
55	PI 511718	A. cruentus Guatemala HH 86
56	PI 511719	A. cruentus Guatemala Niqua, alegria, chang
57	PI 511726	A. cruentus Mexico HH 99
58	PI 511727	A. cruentus Mexico HH 100
59	PI 511732	A. cruentus Guatemala HH 106
60	PI 511876	A. cruentus Mexico Huatle
61	PI 515959	A. cruentus U.S., Montana Montana- 3
62	PI 527567	A. cruentus Burundi IZ 32
63	PI 527570	A. cruentus Rwanda IZ 166
64	PI 536437	A. cruentus Maldives KLM- 1863
65	PI 538320	A. cruentus U.S., Pennsylvania K283
66	PI 538321	A. cruentus U.S., Pennsylvania K436
67	PI 566896	A. cruentus U.S., Arizona RRC 537
68	PI 566897	A. cruentus India, Kerala Kerala Red
69	PI 566898	A. cruentus Mexico RRC 362
70	PI 576447	A. cruentus Nigeria, Oyo Unidentified 1
71	PI 576451	A. cruentus Nigeria, Oyo ED 82/ 1029A
72	PI 576456	A. cruentus Nigeria, Oyo NHA/9A

73	PI 576457	A. cruentus Nigeria, Oyo NHA/13A/
74	PI 576462	A. cruentus Nigeria TB 81/790B
75	PI 576466	A. cruentus Nigeria, Oyo NHA /30A
76	PI 576477	A. cruentus Nigeria TE 81/27A
77	PI 578280	A. cruentus Nigeria, Oyo NHA /15
78	PI 590992	A. cruentus China Tibet
79	PI 604555	A. cruentus Mexico, Morelos Mapes 818
80	PI 604556	A. cruentus Mexico, Morelos Mapes 819
81	PI 604666	A. cruentus U.S., Pennsylvania RRC 1027
82	PI 605353	A. cruentus China RRC 5445
83	PI 605354	A. cruentus U.S., Pennsylvania K 112
84	PI 606767	A. cruentus U.S., Pennsylvania K 277
85	PI 606798	A. cruentus Mexico, Mexico RRC 1032
86	PI 607532	A. cruentus Netherlands, South Holland Split Personality
87	PI 612170	A. cruentus China, Hubei V67
88	PI 618962	A. cruentus Benin RRC 67
89	PI 628780	A. cruentus Mexico, Morelos RRC 423
90	PI 628781	A. cruentus Mexico, Morelos RRC 444
91	PI 628782	A. cruentus Mexico, Morelos RRC 446
92	PI 628783	A. cruentus Mexico, Morelos RRC 776
93	PI 628784	A. cruentus Mexico, Puebla RRC 1139
94	PI 628785	A. cruentus Mexico, Puebla RRC1140
95	PI 628793	A. cruentus Zaire, Shaba RRC 685
96	PI 633584	A. cruentus China, Beijing RRC 27
97	PI 633585	A. cruentus Guatemala, Chimaltenango RRC 624
98	PI 633592	A. cruentus Mexica, Colima RRC 1191
99	PI 641043	A. cruentus Nigeria, Oyo CEN/IB/97/AMA 003
100	PI 641045	A. cruentus Nigeria, Oyo CEN/IB/97/AMA 005
101	PI 642734	A. cruentus Mexico RRC 1012
102	PI 642742	A. cruentus U.S., Pennsylvania K 459
103	PI 643037	A. cruentus Mexico, Federal district RRC 413
104	PI 643039	A. cruentus Mexico, Morelos RRC 415
105	PI 673040	A. cruentus Mexico, Morelos RRC 417
106	PI 643042	A. cruentus Mexico, Morelos RRC 419
107	PI 643043	A. cruentus Mexico, Morelos RRC 420
108	PI 643044	A. cruentus Mexico, Morelos RRC421
109	PI 643045	A. cruentus Mexico, Morelos RRC 422
110	PI 643046	A. cruentus Mexico, Morelos RRC 424
111	PI 643047	A. cruentus Mexico, Morelos RRC 425
112	PI 643048	A. cruentus Mexico, Morelos RRC 426
113	PI 643049	A. cruentus Mexico, Morelos RRC 428
114	PI 643051	A. cruentus Mexico, Morelos RRC 430
115	PI 643052	A. cruentus Mexico, Morelos RRC 431
116	PI 643053	A. cruentus Mexico, Morelos RRC 432
117	PI 643054	A. cruentus Mexico, Morelos RRC 433
118	PI 643055	A. cruentus Mexico, Morelos RRC 434
119	PI 643056	A. cruentus Mexico, Morelos RRC 435
120	PI 643057	A. cruentus Mexico, Morelos RRC 436

121	PI 643060	A. cruentus Mexico, Morelos RRC 441
122	PI 643062	A. cruentus Mexico, Morelos RRC 443
123	PI 643064	A. cruentus Mexico, Morelos RRC 447
124	PI 643077	A. cruentus Mexico, Morelos RRC 463
125	PI 643078	A. cruentus Mexico, Oaxaca RRC 464
126	PI 647848	A. cruentus U.S., California RRC 548
127	PI 649506	A. cruentus Mexico, Tlaxcala RRC 483
128	PI 649408	A. cruentus Mexico, Tlaxcala RRC 491
129	PI 649511	A. cruentus Mexico, Tlaxcala RRC 499
130	PI 649512	A. cruentus Mexico, Tlaxcala RRC 500
131	PI 649513	A. cruentus Mexico, Tlaxcala RRC 501
132	PI 649514	A. cruentus Mexico, Tlaxcala RRC 506
133	PI 649515	A. cruentus Mexico, Puebla RRC 733
134	PI 649516	A. cruentus Mexico, Puebla RRC 734
135	PI 649517	A. cruentus Mexico, Puebla RRC 735
136	PI 649519	A. cruentus Mexico, Puebla RRC 737
137	PI 649520	A. cruentus Mexico, Puebla RRC 738
138	PI 649521	A. cruentus Mexico, Morelos RRC 768
139	PI 649522	A. cruentus Mexico, Morelos RRC 770
140	PI 649523	A. cruentus Mexico, Morelos RRC 771
141	PI 649524	A. cruentus Mexico, Morelos RRC 772
142	PI 649525	A. cruentus Mexico, Morelos RRC 773
143	PI 649526	A. cruentus Mexico, Morelos RRC 779
144	PI 649527	A. cruentus Mexico, Morelos RRC 781
145	PI 649528	A. cruentus Mexico, Puebla RRC782
146	PI 649603	A. cruentus Mexico, Puebla RRC743
147	PI 649609	A. cruentus Mexico, Federal district RRC 774
148	PI 649612	A. cruentus Mexico, Morelos RRC 778
149	PI 658727	A. cruentus Guatemala RRC 384
150	PI 658729	A. cruentus Central African Republic RRC 844
151	PI 658731	A. cruentus U.S., Iowa Y-004-W
152	PI 664489	A. cruentus Mexico, Puebla DB 2010884
153	PI 665285	A. cruentus Venezuela, Falcon RRC 1265
154	PI 665286	A. cruentus Venezuela RRC1266
155	PI 667160	A. cruentus Guatemala RRC 626
156	PI 669937	A. cruentus Tanzania RRC 25
157	PI 669938	A. cruentus Tanzania RRC 56
158	PI 511684	A. hybridus Peru Quihuicha
159	PI 511733	A. hybridus Peru HH 48
160	PI 511734	A. hybridus Bolivia, Chuquisaca HH 52
161	PI 511735	A. hybridus Bolivia HH 53
162	PI 568179	A. hybridus U.S., Iowa Ames 12991
163	PI 572255	A. hybridus U.S., California Aberrant Amaranth
164	PI 608791	A. hybridus U.S., California RRC 382
165	PI 669835	A. hybridus Argentina RRC 550
166	PI 490489	A. hybridus Peru RRC 1119
167	PI 490682	A. hybridus Ecuador LSK 173
168	PI 490694	A. hybridus Ecuador LSK 186
169	PI 500249	A. hybridus Zambia ZM 1845

170	PI 511724	A. hybridus Mexico HH 96
171	PI 603889	A. hybridus U.S., Ohio Pop 42
172	PI 603895	A. hybridus U.S., Indiana Pop 48
173	PI 604568	A. hybridus Mexico, Puebla Mapes 831
174	PI 604602	A. hybridus Mexico, Puebla Basurto 1614
175	PI 604673	A. hybridus U.S., Virginia Ames 14358
176	PI 605351	A. hybridus Greece RRC 847
177	PI 632247	A. hybridus U.S., North Carolina DB 200128
178	PI 636178	A. hybridus U.S., Indiana RRC 100B
179	PI 636180	A. hybridus Colombia, Cundinamarca RRC 1153
180	PI 636181	A. hybridus U.S., Delaware RRC 1195
181	PI 652416	A. hybridus Brazil, Goias CPAC 96-1
182	PI 667156	A. hybridus Equador RRC 610
183	PI 667158	A. hybridus Guatemala RRC 616
184	PI 669837	A. hybridus Bolivia, Tarija RRC 553
185	Ames 5666	A. hypochondriacus India RRC 1193
186	Ames 5667	A. hypochondriacus India, U.P RRC 1194
187	PI 210995	A. hypochondriacus Afganistan RRC 79
188	PI 274276	A. hypochondriacus India, Punjab AVRDC 74-38
189	PI 274279	A. hypochondriacus India, H.P RRC 171
190	PI 337611	A. hypochondriacus Uganda P 373
191	PI 477915	A. hypochondriacus India RRC 1008
192	PI 477916	A. hypochondriacus Mexico RRC 1023
193	PI 477917	A. hypochondriacus Mexico RRC 1024
194	PI 480592	A. hypochondriacus India IC-38061-1
195	PI 480608	A. hypochondriacus India IC-38087
196	PI 480711	A. hypochondriacus India IC-38187
197	PI 480755	A. hypochondriacus India IC-38221
198	PI 480918	A. hypochondriacus India IC-38360
199	PI 481023	A. hypochondriacus India IC-38527
200	PI 481226	A. hypochondriacus India IC-42254-2
201	PI 481134	A. hypochondriacus India IC-42255-5
202	PI 490752	A. hypochondriacus Guatemala LSK 80
203	PI 490758	A. hypochondriacus Mexico RRC 1023
204	PI 511721	A. hypochondriacus Mexico HH 93
205	PI 511731	A. hypochondriacus Mexico RRC 646
206	PI 511877	A. hypochondriacus Mexico Huatle
207	PI 540446	A. hypochondriacus Pakistan RRC 1004
208	PI 558499	A. hypochondriacus U.S., Nabaska PLAINSMAN
209	PI 568125	A. hypochondriacus U.S., Iowa DB921
210	PI 576486	A. hypochondriacus U.S., California UC 126
211	PI 584523	A. hypochondriacus U.S., Colorado Ames 21897
212	PI 599682	A. hypochondriacus Mexico, Sonora RRC 541 segregate
213	PI 604461	A. hypochondriacus Mexico, Puebla Mapes 841 A. hypochondriacus Germany Elephant Head
214	PI 604576	
215	PI 604577	A. hypochondriacus Mexico, Puebla Mapes 847
216	PI 604796	A. hypochondriacus Unknown RRC 147
217	PI 607534	A. hypochondriacus Netherlands, North Holland Pygmy Torch

218	PI 618585	<i>A. hypochondriacus</i> India, Kerala Ames 23941
219	PI 619237	<i>A. hypochondriacus</i> Nepal RRC 124
220	PI 619239	<i>A. hypochondriacus</i> Nepal RRC 138
221	PI 619259	<i>A. hypochondriacus</i> Nepal RRC 266
222	PI 619266	<i>A. hypochondriacus</i> Nepal RRC 283
223	PI 633589	<i>A. hypochondriacus</i> Mexica, chihuahua GN 975
224	PI 643038	<i>A. hypochondriacus</i> Mexico, Federal district RRC 414
225	PI 643041	<i>A. hypochondriacus</i> Mexico, Morelos RRC 418
226	PI 643068	<i>A. hypochondriacus</i> Mexico, Mexico RRC 452
227	PI 649305	<i>A. hypochondriacus</i> China, Heilongjiang HLJ-037
228	PI 649540	<i>A. hypochondriacus</i> Mexico, Tlaxaca RRC 510
229	PI 649579	<i>A. hypochondriacus</i> Mexico RRC 755
230	PI 649607	<i>A. hypochondriacus</i> Mexico, Morelos RRC 767
231	PI 652432	<i>A. hypochondriacus</i> Brazil, Federal district CPAC 96-18
232	PI 654430	<i>A. hypochondriacus</i> Nepal SP 124
233	PI 666334	<i>A. hypochondriacus</i> U.S., Iowa DB 2011434
234	PI 669856	<i>A. hypochondriacus</i> India, U.P UC125
235	PI 669887	<i>A. hypochondriacus</i> India, U.P UC175
236	PI 633586	<i>A. palmeri</i> Senegal, Dakar RRC 654
237	PI 572257	<i>A. powellii</i> Rwanda AMA 89/79
238	PI 572261	<i>A. powellii</i> Germany AMA 57/81
239	PI 538793	<i>A. powellii</i> Russian Federation AJCO73
240	PI 572259	<i>A. powellii</i> Slovakia AMA 69/79
241	PI 572260	<i>A. powellii</i> France AMA 74/82
242	PI 604671	<i>A. powellii</i> U.S., Washington Ames 14356
243	PI 490454	<i>A. quitensis</i> Peru, Apurimac LSK 34
244	PI 490466	<i>A. quitensis</i> Peru LSK 46
245	PI 490706	<i>A. quitensis</i> Equador LSK 203
246	PI 490708	<i>A. quitensis</i> Equador LSK 205
247	PI 511736	<i>A. quitensis</i> Bolivia HH 55
248	PI 511743	<i>A. quitensis</i> Ecuador HH 69
249	PI 511745	<i>A. quitensis</i> Ecuador HH 71
250	PI 511747	<i>A. quitensis</i> Ecuador HH 73
251	PI 511751	<i>A. quitensis</i> Peru Yuyu colorado
252	PI 568154	<i>A. quitensis</i> Bolivia, Tarija aroma
253	PI 649246	<i>A. quitensis</i> Peru, Ancash RRC 928
254	PI 652419	<i>A. quitensis</i> Brazil, Goias CPAC 96-4
255	PI 652428	<i>A. quitensis</i> Brazil, Federal district CPAC 96-14
256	PI 669830	<i>A. quitensis</i> Ecuador RRC 596
257	PI 669836	<i>A. quitensis</i> Argentina, Santa Fe RRC 552
258	PI 669839	<i>A. quitensis</i> Peru RRC 560
259	PI 636366	<i>A. retroflexus</i> Unknown RRC 112C
260	PI 649310	<i>A. retroflexus</i> Mongolia E94193

Supplementary Table S3: Morphological traits and number given to them

1) Petiole Pigmentation	Categories	Scale
	Yellow	1
	Orange	2
	Green	3
	Dark green	4
	Amaranthine	5
	Dark amaranthine	6
2) Blade Pigmentation	Categories	Scale
	Normal green	1
	Band area pigmented	2
	Speckled	3
	Sectoring patches	4
	One strip (V-shaped)	5
	Margin and vein pigmented	6
	Entire lamina Amaranthine	7
	Dark green	8
	Two stripes (V- shaped)	9
	Central Spot	10
	Chlorophyll deficient	11
	Mixed	12
3) Blade shape	Categories	Scale
	Trullate	1
	Lanceolate	2
	Oblong	3
	Obovate	4
	Obtriangular	5
	Obtrullate	6
	Ovate	7
	Rhombic	8
	Triangular	9
	Elleptic	10
	Oval	11
	Obdurate	12
4) Stem color	Categories	Scale
	White	1
	Combination with white	2
	Orange	3
	Pink base and pink stem	4
	Red or darker base and green stem	5
	Solid Amaranthine	6
	Amaranthine striped	7
	Pink base but green stem	8
	Green with dark green stripes	9
	Green	10
	Mixed	11
	Other	12
5) Branching index	Categories	Scale

	Branching all along whole stem	1
	Many branches near base	2
	Few branches near base	3
	Mixed	4
	Few branches	5
	No branches	6
6) Flower color	Categories	Scale
	White	1
	Orange	2
	Rufescent (Rusty)	3
	Light Amaranthine	4
	Dark Amaranthine	5
	Mixed	6
	Other	7
7) Inflorescence density	Categories	Scale
	High	1
	Low	2
	Intermediate	3
	Mixed	4
	Other	5
8) Inflorescence Shape	Categories	Scale
	Short side branches 1	1
	Terminal 2	2
	Mixed 3	3
	Other 4	4
	Long side branches 5	5
	Spiked 6	6
9) Terminal Inflorescence Type	Categories	Scale
	Horizontal	1
	Erect	2
	Drooping	3

Supplementary Table S4: Significance of morphological traits on different clusters of all accessions combined across USDA and SSE collections.

Morphological Trait	Clusters	Error	P>F
BP	832.64**	1.46	<0.0001
BS	616.96**	2.38	<0.0001
PP	14.30**	1.15	<0.0001
BI	5.07	4.35	0.3254
FC	26.37**	3.51	<0.0001
IS	2.48	0.97	0.0204
ID	4.41	1.97	0.0401
TIA	2.58	0.65	0.0008
SC	34.18**	5.64	<0.0001

**Significant at $P < 0.0001$,

Morphological Trait Abbreviations: BP = Blade pigmentation, BS = Blade shape, PP = Petiole Pigmentation, BI = Branching Index, FC = Flower color, IS = inflorescence Shape, ID = Inflorescence Density, TIA = Terminal Inflorescence Attitude, SC = Stem color

Supplementary Table S5: Nearest cluster analysis based on Mahalanobis D2 distance between groups found among all accessions combined across USDA and SSE Amaranths genotypes.

Cluster	1	2	3	4	5	6	7
1		9.593	11.19	12.05	9.485	7.984	7.549
2	9.593		7.017	8.831	5.425	11.86	9.662
3	11.19	7.017		4.491	8.847	8.197	11.12
4	12.05	8.831	4.491		8.157	9.1	14.19**
5	9.485	5.425	8.847	8.157		12.49	12.81
6	7.984	11.86	8.197	9.1	12.49		9.882
7	7.549	9.662	11.12	14.19	12.81	9.882	

**Significant at $P < 0.0001$,