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## Evaluation of Red Pepper for Spice (*Capsicum annuum* L.) Germplasm Resource of Kahramanmaras Region (Turkey)

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**Abstract:** Red hot pepper production for spices is very important for Kahramanmaras City located in Eastern Mediterranean Region of Turkey as around the world. However, there are major production problems. One of the biggest problems is absence of improved variety yet inside of cultivated peppers and low quality of seed material in region. In experiment, 115 red hot pepper accessions for spice production originally collected from region were evaluated based on quantitative and qualitative characters. When accessions were evaluated based on each one character, successful of accessions varied. Therefore accessions were evaluated with weighed grade method and 17, 122, 43 and 140 (elongate), 52, 135 and 51 (triangular), 118 (campanulate) and 123, 26 and 65 (blocky) accessions were selected as use in breeding research of red hot spice pepper in Kahramanmaras.

**Key words:** Red pepper (*Capsicum annuum* L.), germplasm, selection

### INTRODUCTION

Peppers (*Capsicum* spp.) have been grown for several thousand years in the Americas. Since their introduction into the old world, peppers are cultivated in various environments and a number of different types were developed<sup>[1,2]</sup>.

Red (hot, chilli, paprika) pepper for spice is one of the important types in all pepper<sup>[3]</sup>. Spice peppers are produced great amount in the world<sup>[4,5]</sup>. Turkey is one of the countries for spice pepper. Especially, red pepper for spices is of the most important source for south and southeast cities of Turkey<sup>[6]</sup>. The best material has been grown in Kahramanmaras city<sup>[7]</sup>. Turkey red spice pepper production is 21340 tons in 8094 ha and Kahramanmaras has proved 26.5% of this production in 1610 ha in 2000. Approximately 50 factories have activated for process fresh red pepper as dry pepper with 18.000 ton/year in region. Export potential of red pepper as spices has great economic important. Turkey exported 1402 tons red pepper as spice and obtained 5259 thousand dollars income<sup>[8]</sup>.

However there are major production constraints. Quality of seed material is very low due to farmers are reproduced pepper themselves. Seed have not obtained in production rules by farmers lack of the knowledge. This case have caused to genetic confusion<sup>[7]</sup>. An improved variety has not existed yet and the production material is still population. Therefore, yield and quality has gradually decreased. Even, farmers has abandoned from hot pepper

production. Kahramanmaras pepper germplasm resource has in disappearance risk.

It is absolutely necessary to collect and preserve the local varieties before the disappearance of such material have wide range of variation in many characters. Because, evaluating and grouping of landraces of a crop of a certain region is helpful for the study of the evolutionary relationships in line with the history of the crop in that region and also helpful for crop improvement to make crosses between apparently unrelated genotypes. Furthermore, screening, documenting and storing of germplasm allows efficient utilization<sup>[2,9,10]</sup>.

There are many different varieties, forms; and uses of *Capsicum*. This variation is also reflected in the goals and objectives needed to breed for quality. The strategy of the *Capsicum* breeder is to assemble into a cultivar the superior genetic potential for yield, protection against production hazards and improved quality<sup>[3]</sup>.

Therefore the present study was conducted to evaluate Kahramanmaras red hot pepper germplasm resource and determine suitable breeding beginning lines based on their quantitative and qualitative characters.

### MATERIALS AND METHODS

Total 115 hot pepper (*Capsicum annuum* L.) accessions were originally collected in 1998-2000 by us from Kahramanmaras, Eastern Mediterranean, Turkey (Table 1).

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Table 1: Collection site of hot pepper accessions according to fruit shape in experiment

Site	Accessions with elongate fruits	Accessions with triangular fruits	Accessions with campanulate fruits	Accessions with blocky fruits
Beyoglu	14, 23, 32	11, 67, 108	98	31, 90
Cakallicullu	46	42	-	123
Cakallihasanaga	105	-	131	-
Ceceli	12, 69	125	-	111
Cigli	22, 57, 127	15, 50, 88	73, 81	-
Cinarli	53, 117, 130	4, 76	-	25
Cokyasar	28, 64	-	-	132
Doganli	48, 95	27, 138	-	-
Gulluhuyuk	71	16	68	-
Guzelyurt	62, 124	2, 120	89	19
Hacibebek	36	33	-	-
Karacasu	45, 80	115, 137	-	-
Kilili	59, 91, 140	13, 52, 110	-	103
Kizilenis	1, 24, 104	34, 74, 112	-	7
Kocalar	39, 63	18	-	-
Minehuyuk	54	35	-	26
Narlicerkezler	85	51, 84	-	-
Narli	43, 107, 119	66, 101, 126	-	-
Pazarcik	21, 55, 122	8, 49, 82, 135	-	102
Şekeroba	30, 44, 96	9, 47, 92	77	-
Tevekkeli	106	97	-	128
Turkoglu	17, 41, 136	70, 114, 139	61, 118	65, 72
Yolboyu	20, 75	5, 109	-	-

Open field experiments was carried out in randomized complete block design with three replications in 2001. Each treatment had a single row with fifteen plants in each replication. Seeds of each accession were sown in pots and after eight weeks, seedlings were transplanted to open field. Spacing of 60 and 40 cm between rows and plants were used respectively. Peppers was cultivated as to Somos<sup>[11]</sup> and Vural *et al.*<sup>[12]</sup>. Peppers were harvested in the 5th month after the sowing in order to fruits matured.

Data of 16 characters as quantitative and qualitative were collected based on International Plant Genetic Resources Institute, IPGRI<sup>[13]</sup> descriptor lists from the five plants and twenty fruits. The characters were recorded as quantitative (e.g. fruit yield) and qualitative (e.g. fruit colour, fruit shape, fruit pungency). Quantitative characters were used directly while for each qualitative characters were transformed as quantitative characters (Table 2).

The types were evaluated with changed Weighed Grade Method using by Barut *et al.*<sup>[14]</sup> and Balkaya and Yanmaz<sup>[15]</sup> in four different class with elongate (48), triangular (44), campanulate (9) and blocky (14) fruit shape. In order to calculation of weighed grade point of a type: percentage importance of a character multiplied by value of characters and then these values summed. Weighed grade values of accessions means of the three replicates were analyzed with F test. Differences between the mean values were compared utilizing Fischer's least significant test.

## RESULTS AND DISCUSSION

**Evaluation of accessions for each characteristics:** During the experiment, 115 red hot pepper accessions were evaluated with quantitative and qualitative characters are very important for pepper, especially spice production (Table 2). Because, within a certain region variation for plant and fruit types is observed and their presence is mainly caused by human preference<sup>[2]</sup>. Therefore, quantitative and qualitative characters based on fruit were priority evaluated<sup>[16]</sup> to meet the need for demands of farmers in this research. Red hot peppers were separately considered into four groups with elongate, triangular, campanulate and blocky fruit shape. But firstly, performance of accessions were evaluated individual based on each characteristics.

Dry fruit yield is the most important components for spice pepper production<sup>[17]</sup>. Increasing of dry fruit yield is mean much more economic gain in red hot pepper production. Dry fruit yield as ripe per plant ranged from 13.4 to 94.6 g among the red hot pepper with different fruit shape (Table 2). This finding is almost consistent with those of Srirama Chandra Murthy *et al.*<sup>[18]</sup> and Alegbejo *et al.*<sup>[19]</sup>. But, present findings were not exactly suitable with those of Mishra *et al.*<sup>[20]</sup> and Zewdie<sup>[21]</sup> who reported that marketable dry yield were between 23.3-28.1 and 26.0-347.0 g plant<sup>-1</sup>, respectively. This difference certainly caused by genetic and environmental reasons. The maximum weighed grade points (WGP) in dry fruit yield

Table 2: Characters for selection of hot pepper accessions; importance percentage of characters in Weighed Grade Method; min and max values of characters in accessions with different fruit shape

Characters	Importance %	Elongate (min-max)	Triangular (min-max)	Campanulate (min-max)	Blocky (min-max)
DFY = Dried fruit yield as ripe per plant (g)	15	19.3-94.6	13.4-86.2	23.0-81.6	16.1-82.7
RFY = Ripe fruit yield per plant (g)	12	121.5-567.7	82.5-531.3	186.3-511.3	96.7-488.1
PDFY = % of dried fruit yield as ripe per plant (DFY/RFY*100)	10	8.9-16.8	8.5-16.8	9.7-15.8	9.0-16.6
FY = Fruit yield per plant (g)	8	143.2-685.8	104.8-643.6	203.0-543.8	163.2-573.5
NRF = ripe fruit numbers per plant	7	16.7-73.2	11.8-80.6	16.7-56.1	15.7-67.2
NF = Number of fruits per plant	7	17.8-86.4	13.1-84.1	17.6-60.9	21.4-72.9
FWT = Fruit wall thickness (mm)	6	0.9-2.1	0.9-1.9	1.2-2.1	1.1-1.9
PRFN = Percentage of ripe fruits number per plant (NRF/NF*100)	6	68.0-98.8	70.9-98.5	79.9-97.2	71.1-96.9
PRFY = Percentage of ripe fruits yield per plant (RFY/FY*100)	6	68.0-98.2	69.7-96.0	80.2-95.0	59.3-94.4
FCR = Fruit color in ripe: 1-green, 2-yellow, 3-orange, 4-red, 5-purple	5	4-5	4-5	4-4	4-5
FW = Fruit weight (g)	3	5.5-14.4	5.4-15.1	6.6-13.1	6.5-12.4
FL = Fruit length (cm)	3	5.6-15.6	5.4-12.6	5.3-10.6	4.7-9.9
FWD = Fruit width (cm)	3	0.9-3.6	1.6-3.8	2.1-4.1	2.3-4.1
SW = 1000-seed-weight (g)	3	5.3-21.1	6.7-21.9	7.3-20.2	7.4-20.6
NS = Number of seeds per fruit	3	25.0-109.8	31.3-112.0	36.8-103.5	37.8-105.8
RFP = Fruit pungency: 0-sweet, 3-low, 7-intermediate, 9-high	3	3-9	3-9	7-7	3-9

were reached in 52 (13.4), 118 (13.3), 51 (12.8), 123 (12.8), 49 (11.9), 26 (11.5), 135 (11.4) and 1 (11.5) accordance with Table 3-6.

Ripe fruit yield is one of important character as much as dry fruit yield<sup>[17]</sup>. Ripe fruit yield also affects dry fruit yield and economic gain. Among the types, ripe fruit yield per plant of the peppers ranged from 82.5 to 567.7 (Table 2). These results were almost similar with previous studies<sup>[4, 22-24]</sup>. Accessions of 17 and 118 with 11.5 WGP were the most successful in pepper accessions for this character. Also 52 and 123 were important accessions with 11.4 and 11.3 WGP, respectively (Table 3-6).

Percentage of dried fruit yield indicates to efficiency of spice production. Percentage of dried fruit yield as ripe per plant were between 8.5-16.8% in accessions (Table 2). Accessions of 82 and 118 with 8.9 WGP had the greatest in percentage of dried fruit yield. These accessions were followed by 42 and 89 with 8.8 WGP and 26 and 123 with 8.5 WGP (Table 3-6).

Fruit yield importance is low in this experiment. Because plants have immature fruits at the harvest time that these fruits are not use in red pepper spice production. But still, fruit yield is important character that all agricultural activities aim is yield<sup>[16,25]</sup>. While fruit yield of the accessions were average 395.3 g and ranged from 104.8 to 685.8 g plant<sup>-1</sup> (Table 2). Our results agree with those of Zewdie and Poulos<sup>[26]</sup>, Catala and Costa<sup>[27]</sup> and Patel *et al.*<sup>[28]</sup> who reported that fruit yield were between 201-441, 100-410 and 443-470 g plant<sup>-1</sup>, respectively. The highest fruit yield were obtained from 7 and 17 with 7.7 WGP, followed by 52 and 118 with 7.6 WGP (Table 3-6).

Fruit number is relation with yield<sup>[16]</sup>. For this reason, ripe and all fruit number per plant were determined in this investigation. While ripe fruit number ranged 11.8-80.6, all fruit number changed between 13.1-86.4 in red hot pepper plants (Table 2). Almost equivalent values for fruit number has been reported some previous studies<sup>[22,24,29]</sup>. Accession No. 17, 73 and 135 were first in all peppers, followed by 123, 118 and 43 for ripe and all fruit number. Also 7 was the other important accession in all fruit number (Table 3-6).

Fruit wall thickness very important character for spice pepper production<sup>[16]</sup> because of industrial process<sup>[30]</sup>. In the event of fruit wall thickness decrease, spice production is easy that fruits is dry in a short time. Also fruits are easily separate and grind. In this case process cost is decreased. In our experiment, fruit wall thickness changed from 0.9 to 2.1 (Table 2). This results were confirmed by Joshi *et al.*<sup>[22]</sup> and were almost similar to results of Fuentes and Mora<sup>[31]</sup>. Acc. No 31 was the greatest with 5.8 WGP, followed by 73 with 5.6 WGP. On the other hand 16, 23, 39, 81 and 140 were the other important accessions in fruit wall thickness (Table 3-6).

Percentage of ripe fruits number (PRFN) and yield (PRFY) are very important for spice performance of red hot pepper accessions. Because these characters show that how much yield can be obtain in all pepper crop for spice. While PRFN ranged from 68.0 to 98.8%, PRFY changed between 68.0-98.2 in all accessions (Table 2). Accessions of 118, 122 and 137 with 6.0 WGP were the greatest for PRFN. The highest PRFY were in 118 and 137 with 6.0 WGP (Table 3-5)

Table 3: Weighed grade of accessions with elongate fruit shape in different characters, P=0.001, n=3 (Comparisons between means were made with Fischer's LSD test within total column. Values followed by a common letter are not significantly different, LSD<sub>0.1</sub>=5.57. See Table 2 for characters)

Acc.	DFY	RFY	PDFY	FY	NRF	NF	FWT	PRFN	PRFY	FCR	FW	FL	FWD	SW	NS	RFP	WGP
17	12.6	11.5	7.1	7.7	6.7	6.8	3.6	5.1	5.0	4.0	1.7	1.4	2.2	2.1	2.1	2.3	81.98a
122	10.2	9.8	7.9	5.6	5.8	5.0	4.2	6.0	5.9	4.0	1.6	1.9	1.6	2.9	2.8	2.3	77.55ab
43	10.1	9.9	7.3	6.1	6.0	5.5	2.9	5.5	5.5	4.0	1.6	1.6	2.2	2.8	2.8	3.0	76.79a-c
140	10.8	9.9	7.2	6.6	5.2	4.9	5.1	5.5	5.1	4.0	1.9	2.4	1.6	1.7	1.7	2.3	75.99b-d
1	11.4	10.4	7.4	6.7	3.5	3.4	4.6	5.3	5.2	4.0	2.9	2.1	2.6	1.6	1.6	2.3	74.87b-e
23	9.6	9.6	6.6	6.3	4.6	4.6	5.1	5.2	5.1	4.0	2.0	1.9	2.1	2.8	2.8	2.3	74.55b-e
117	9.3	9.0	7.8	5.2	4.5	4.0	3.6	5.9	5.8	4.0	1.9	1.6	2.1	2.7	2.7	2.3	72.43b-e
45	9.1	8.1	8.0	5.0	4.9	4.6	4.5	5.5	5.4	4.0	1.6	2.1	1.6	2.8	2.7	2.3	72.37b-e
106	9.5	8.4	7.6	5.5	4.1	4.0	4.4	5.3	5.2	4.0	2.0	2.0	2.2	2.7	2.7	2.3	71.74b-f
105	9.4	8.7	7.5	5.5	4.4	4.1	3.1	5.6	5.3	4.0	2.0	2.0	2.5	2.7	2.7	2.3	71.70b-f
24	10.3	8.9	7.7	5.8	4.6	4.5	3.6	5.3	5.2	4.3	1.9	1.7	2.3	1.7	1.7	1.9	71.43b-g
55	9.3	7.8	8.4	4.9	3.8	3.5	4.1	5.7	5.4	4.0	2.0	2.9	1.5	2.7	2.7	2.3	70.94c-h
62	8.8	8.7	7.0	5.5	4.4	4.2	3.5	5.4	5.3	4.0	1.9	1.5	2.7	2.6	2.6	2.3	70.41c-I
75	8.7	7.9	8.2	4.7	5.4	4.8	2.9	5.7	5.7	4.0	1.4	1.8	1.4	2.4	2.4	2.3	69.82d-j
53	9.0	8.2	7.7	5.1	3.7	3.4	3.2	5.5	5.4	4.0	2.2	1.6	2.5	2.7	2.7	3.0	69.65d-k
63	8.1	7.6	8.0	4.4	4.9	4.3	4.3	5.9	5.8	4.0	1.5	2.0	1.6	2.2	2.2	3.0	69.60d-k
14	8.0	8.0	6.8	5.1	5.0	4.8	4.3	5.3	5.3	4.3	1.5	1.6	2.0	2.7	2.7	1.4	68.76e-l
91	7.7	7.1	8.2	4.1	5.1	4.5	2.9	5.8	5.8	4.0	1.3	1.3	1.5	1.8	1.8	2.3	65.40f-m
127	7.3	6.6	7.5	4.3	4.4	4.2	4.4	5.5	5.2	4.0	1.5	1.9	1.8	2.1	2.1	2.3	65.23g-m
69	7.2	7.0	7.3	4.3	4.2	3.9	4.3	5.5	5.4	4.0	1.6	1.7	1.8	2.3	2.3	2.3	65.10g-m
20	7.1	6.9	5.8	5.4	4.3	5.3	4.6	4.2	4.3	4.3	1.5	1.4	2.2	2.6	2.6	2.3	64.89h-n
57	7.4	7.2	7.3	4.5	3.7	3.5	3.1	5.5	5.4	4.0	1.8	1.9	1.9	2.4	2.4	2.3	64.52h-o
104	7.4	6.9	7.6	4.3	3.4	3.1	4.3	5.7	5.4	4.0	2.0	2.2	2.0	1.9	1.9	2.3	64.44h-o
32	7.8	7.0	6.8	5.0	3.6	4.2	4.1	4.5	4.7	4.0	1.7	1.5	2.2	2.4	2.4	2.3	64.15i-o
30	7.5	6.9	7.0	4.7	3.9	4.6	3.4	4.4	4.9	4.7	1.5	1.3	2.0	2.6	2.6	1.4	63.51j-p
124	7.1	6.6	7.8	4.0	4.4	4.0	3.3	5.7	5.5	4.0	1.5	1.7	2.0	1.9	1.8	2.3	63.49j-q
41	6.7	6.4	7.7	3.8	4.4	4.0	4.3	5.7	5.7	4.0	1.4	1.8	1.5	1.7	1.6	2.3	63.13k-q
136	7.1	6.3	7.7	4.0	4.2	4.1	4.2	5.3	5.3	4.0	1.4	1.9	1.6	1.9	1.8	2.3	62.99l-q
59	7.0	6.7	7.5	4.1	4.0	3.7	3.0	5.7	5.5	4.0	1.6	1.6	2.1	1.8	1.8	2.3	62.38l-r
36	6.8	6.8	7.6	3.9	3.6	3.3	4.1	5.7	5.8	4.0	1.8	1.9	1.8	1.3	1.2	2.3	61.90m-r
64	7.2	6.1	8.3	3.8	3.0	2.8	3.7	5.6	5.4	4.0	2.0	1.6	2.4	1.7	1.6	2.3	61.37m-r
119	6.9	6.2	7.8	3.9	2.8	2.6	4.2	5.4	5.3	4.0	2.2	2.0	1.9	1.9	1.8	2.3	61.26m-r
71	6.7	6.1	7.9	3.7	3.9	3.5	3.4	5.7	5.6	4.0	1.5	1.8	1.6	1.5	1.4	2.3	60.77m-r
21	6.5	6.2	6.3	4.6	2.7	3.1	4.8	4.5	4.6	4.3	2.1	1.7	2.2	2.5	2.4	1.4	59.97m-r
12	6.6	6.4	6.8	4.3	2.8	2.8	4.1	5.1	5.0	4.0	2.3	1.5	2.4	2.2	2.2	1.4	59.92m-r
46	6.2	6.2	6.6	4.1	3.1	3.1	4.3	5.1	5.1	4.0	1.9	1.8	2.0	2.0	1.9	2.3	59.83m-r
44	6.3	6.0	7.0	3.9	3.0	2.9	3.5	5.4	5.2	4.0	2.0	1.8	2.6	2.0	1.9	2.3	59.77m-r
54	5.9	5.7	7.8	3.3	3.7	3.3	4.5	5.8	5.8	4.0	1.5	1.7	1.6	1.3	1.3	2.3	59.67m-r
39	6.1	5.4	7.4	3.6	3.0	2.9	5.1	5.3	5.1	4.0	1.8	1.8	1.9	1.4	1.4	2.3	58.37n-r
96	6.2	5.6	7.4	3.7	3.2	3.1	3.6	5.2	5.1	4.0	1.7	2.0	1.8	1.6	1.6	2.3	58.21n-r
85	5.8	5.2	8.1	3.2	3.3	2.9	4.2	5.7	5.5	4.0	1.6	2.1	1.4	1.1	1.0	3.0	58.06o-r
48	5.5	5.3	7.2	3.4	4.0	3.8	4.2	5.4	5.3	4.0	1.3	1.6	1.6	1.3	1.2	2.3	57.31p-r
80	6.0	5.4	7.8	3.3	3.5	3.2	3.9	5.7	5.5	4.0	1.5	1.6	1.9	1.4	1.3	1.0	57.10p-r
95	5.3	5.0	7.2	3.2	3.1	2.9	4.3	5.6	5.3	4.0	1.6	1.6	2.4	1.5	1.5	2.3	56.84p-r
22	5.6	5.0	7.9	3.1	3.4	3.1	4.5	5.5	5.4	4.0	1.4	1.5	1.8	1.2	1.1	2.3	56.84p-r
107	5.7	5.1	7.6	3.3	2.2	2.0	4.3	5.6	5.3	4.0	2.3	2.2	1.9	1.5	1.4	2.3	56.75gr
28	4.9	4.7	7.0	3.1	2.4	2.4	3.8	5.2	5.2	4.3	1.8	1.9	2.1	2.5	2.5	2.3	56.08r
86	4.9	4.9	6.9	3.1	3.2	3.0	4.3	5.6	5.3	4.0	1.5	1.8	2.2	1.4	1.4	2.3	55.77r

Fruit colour is one of the important quality criterion in red spice production<sup>[3,18,32,33]</sup>. Turning from red to purple of fruit colour is increased market worth. All fruit colours of accessions were red or slightly red-purple colour in this investigation (Table 2) as in previous studies<sup>[9,24]</sup>. It is very strange that all campanulate fruit shape peppers had red-purple colour (Table 5). Also accession 30 were almost same colour (Table 3).

When industrial and agricultural activities have thought large fruit size is usually preferred. Because large fruits is very more suitable than the small for gathering from field, transportation, processing like washing,

separating, drying and grinding. The most important indicators are fruit weight, fruit length and fruit width<sup>[16]</sup>. Fruit weight ranged 5.4-15.1 g. While fruit length were between 4.7-15.6 cm, fruit width were between 0.9-4.1 cm (Table 2). Our results almost agree with those of Catala and Costa<sup>[27]</sup> who found that fruit weight changed between 9.27-13.49. Patel *et al.*<sup>[28]</sup> who reported that fruit length ranged from 8.99 to 10.77 cm and fruit width ranged from 1.0 to 4.4 cm. Zewdie<sup>[21]</sup> who determined that fruit width altered from 0.56 to 3.30 cm. Acc. No 1 with 2.9, 90 with 2.8, 5 with 2.6 and 68 with 2.6 were the successful peppers in fruit weight. The greatest weighed grade

Table 4: Weighed grade of accessions with triangular fruit shape in different characters, P=0.001, n=3 (Comparisons between means were made with Fischer's LSD test within total column. Values followed by a common letter are not significantly different, LSD<sub>0.01</sub>=5.42. See materials and methods for characters)

Acc.	DFY	RFY	PDFY	FY	NRF	NF	FWT	PRFN	PRFY	FCR	FW	FL	FWD	SW	NS	RFP	WGP
52	13.4	11.4	7.5	7.6	4.5	5.0	3.5	5.2	5.2	4.0	2.0	2.0	2.6	2.7	2.8	2.3	81.68a
135	11.5	10.2	8.0	6.1	6.7	6.7	3.1	5.8	5.7	4.0	1.2	1.8	2.6	2.7	2.7	2.3	80.94a
51	12.8	10.9	7.9	6.9	4.6	5.0	3.0	5.4	5.4	4.0	1.8	2.2	2.4	2.7	2.7	2.3	80.15ab
49	11.9	10.3	7.9	6.5	4.9	5.4	3.2	5.3	5.5	4.0	1.6	2.0	1.7	2.7	2.8	1.0	76.68a-c
42	11.4	9.2	8.8	5.5	4.9	4.9	3.2	5.8	5.8	4.0	1.5	1.7	1.8	2.7	2.7	2.3	76.28a-c
67	11.0	9.8	7.8	6.0	4.4	4.7	3.3	5.5	5.6	4.0	1.7	1.6	2.8	2.6	2.7	2.3	75.76a-d
115	10.1	9.3	7.5	5.7	4.4	4.5	3.4	5.8	5.6	4.0	1.7	2.5	2.2	2.6	2.6	2.3	74.34b-e
137	9.8	9.4	7.6	5.4	4.4	4.3	3.5	6.0	6.0	4.0	1.7	2.0	1.6	2.6	2.6	2.3	73.11c-f
82	10.0	8.1	8.9	4.8	4.5	4.6	3.6	5.8	5.8	4.0	1.4	2.1	1.7	2.3	2.3	2.3	72.24c-g
66	8.4	8.5	6.9	5.2	3.7	3.8	4.1	5.6	5.6	4.0	1.8	1.9	2.6	2.8	2.8	2.3	70.01d-h
70	9.1	7.9	8.0	4.8	3.6	3.7	3.8	5.8	5.6	4.0	1.8	2.2	1.9	2.3	2.4	2.3	69.20e
8	8.8	7.8	7.3	5.1	3.0	3.5	4.6	5.1	5.3	4.0	2.0	1.9	2.3	2.7	2.7	2.3	68.55e-j
92	8.6	8.0	7.1	5.1	3.7	4.0	3.2	5.3	5.3	4.0	1.7	1.8	2.6	2.5	2.5	2.3	67.95f-k
138	8.0	7.6	7.4	4.6	3.9	4.0	3.1	5.8	5.7	4.0	1.5	1.7	2.6	2.3	2.3	3.0	67.52f-k
74	8.6	7.6	8.2	4.5	4.2	4.2	3.7	5.9	5.8	4.0	1.4	1.7	2.3	2.1	2.1	1.0	67.08f-l
13	8.4	7.4	7.2	5.0	3.3	3.8	3.5	5.0	5.1	4.0	1.7	1.6	2.7	2.6	2.6	2.3	66.25g-m
109	8.2	7.3	7.9	4.4	3.0	3.0	3.3	5.7	5.7	4.0	2.0	1.7	2.5	1.9	2.0	3.0	65.57h-n
97	7.9	6.9	7.9	4.2	4.2	4.4	3.7	5.7	5.7	4.0	1.3	2.0	1.7	1.5	1.6	2.3	64.97h-n
76	8.3	7.2	8.1	4.4	2.8	2.9	3.5	5.7	5.7	4.0	2.0	1.8	2.6	1.8	1.8	2.3	64.92h-n
18	8.0	7.4	5.9	5.8	3.6	4.8	3.3	4.3	4.4	4.3	1.6	1.8	2.5	2.3	2.3	2.3	64.60h-n
114	7.5	6.7	7.9	4.1	4.2	4.2	3.3	5.8	5.7	4.0	1.3	1.9	1.9	1.6	1.7	2.3	64.21h-o
33	7.6	6.7	7.1	4.6	3.6	4.2	3.5	5.0	5.1	4.0	1.5	1.8	2.1	2.1	2.1	2.3	63.39i-o
112	7.7	7.3	7.4	4.4	2.8	2.9	3.1	5.6	5.7	4.0	2.0	1.9	2.0	1.9	1.9	2.3	63.19i-o
101	7.7	6.8	7.8	4.2	2.6	2.6	3.3	5.8	5.6	4.0	2.1	2.0	2.5	1.8	1.8	2.3	63.06i-p
16	7.9	6.7	7.1	4.8	2.4	2.9	5.1	4.8	4.9	4.0	2.2	2.0	2.7	1.6	1.6	2.3	62.97i-p
110	7.4	6.4	8.1	3.9	2.9	2.9	3.5	5.9	5.7	4.0	1.8	1.6	2.8	1.6	1.6	2.3	62.45j-q
47	7.3	6.9	6.4	4.8	3.2	3.8	3.3	4.8	4.9	4.0	1.7	2.0	2.4	2.3	2.3	2.3	62.40j-q
15	7.2	6.1	7.0	4.4	3.8	4.8	4.3	4.6	4.8	4.3	1.2	1.5	2.1	1.9	1.9	2.3	62.27j-q
34	7.2	6.5	7.7	4.1	3.0	3.2	3.3	5.5	5.5	4.0	1.7	1.8	2.2	1.8	1.8	2.3	61.67k-q
11	6.9	6.5	6.3	4.7	2.7	3.5	4.1	4.5	4.8	4.0	1.8	1.8	2.3	2.3	2.3	2.3	60.88l-r
4	7.2	6.8	6.6	4.6	2.2	2.6	3.2	4.9	5.0	4.0	2.4	2.0	2.4	2.2	2.2	2.3	60.70l-r
139	7.3	6.3	7.7	4.0	2.6	2.7	3.5	5.5	5.5	4.0	2.0	1.7	2.6	1.3	1.3	2.3	60.31m-s
5	6.9	6.4	6.5	4.5	1.8	2.3	3.9	4.6	4.9	4.0	2.6	2.0	2.8	2.3	2.3	2.3	60.12m-s
50	6.8	6.6	6.5	4.4	2.5	2.9	3.5	5.0	5.2	4.0	2.0	2.0	2.1	1.9	1.9	2.3	59.66n-s
2	6.3	5.8	6.3	4.2	3.6	4.6	3.0	4.6	4.7	4.3	1.2	1.5	2.0	1.7	1.7	2.3	57.94o-t
108	5.6	5.0	7.8	3.1	3.5	3.7	3.3	5.5	5.5	4.0	1.1	1.7	1.7	1.5	1.5	2.3	56.69p-t
88	5.6	5.5	7.1	3.4	2.4	2.4	3.3	5.8	5.6	4.0	1.9	1.8	2.4	1.4	1.4	2.3	56.26q-t
9	6.0	5.5	6.2	4.1	1.9	2.4	3.5	4.6	4.7	4.0	2.3	1.9	2.5	1.7	1.7	2.3	55.37r-u
27	5.2	5.0	6.4	3.4	2.3	2.8	4.2	4.8	5.0	4.3	1.6	2.1	2.1	1.7	1.7	2.3	54.98ru
84	4.7	4.4	7.0	2.9	1.9	2.0	4.4	5.5	5.3	4.0	1.9	1.8	2.7	1.4	1.4	3.0	54.23su
126	5.2	4.5	7.2	3.1	2.1	2.4	3.3	5.1	5.1	4.0	1.7	2.0	2.3	1.5	1.5	2.3	53.40tu
120	4.7	4.6	6.5	3.1	1.5	1.6	4.1	5.3	5.1	4.0	2.5	2.3	2.5	1.4	1.4	2.3	52.97tu
35	4.4	3.9	7.2	2.6	1.5	1.6	3.8	5.4	5.1	4.0	2.2	2.4	2.4	1.0	0.9	1.0	49.37uv
125	2.8	2.4	7.4	1.6	1.2	1.3	3.0	5.5	5.2	4.0	1.7	2.0	1.9	1.5	1.5	2.3	45.09v

Table 5: Weighed grade of accessions with campanulate fruit shape in different characters, P=0.001, n=3 (Comparisons between means were made with Fischer's LSD test within total column. Values followed by a common letter are not significantly different, LSD<sub>0.01</sub>=7.27. See materials and methods for characters.)

Acc.	DFY	RFY	PDFY	FY	NRF	NF	FWT	PRFN	PRFY	FCR	FW	FL	FWD	SW	NS	RFP	WGP
118	13.3	11.5	8.9	7.6	6.1	5.8	4.6	6.0	6.0	5.0	2.4	2.3	2.4	2.7	2.7	3.0	90.11a
73	9.2	8.4	7.9	5.9	6.7	6.6	5.6	5.7	5.6	5.0	1.6	2.3	1.8	2.8	2.8	3.0	80.73b
61	10.3	9.1	7.8	6.8	5.0	5.3	3.7	5.4	5.3	5.0	2.3	2.3	2.8	2.9	2.9	3.0	79.95bc
77	8.8	8.3	7.8	5.7	4.8	4.7	5.3	5.8	5.8	5.0	2.1	2.0	2.3	2.4	2.5	3.0	76.44bc
81	8.3	7.5	7.8	5.4	3.8	3.8	5.1	5.6	5.6	5.0	2.5	1.9	2.7	2.2	2.2	3.0	72.45c
98	5.8	5.5	7.6	3.9	4.2	4.1	4.1	5.8	5.6	5.0	1.7	1.9	2.4	1.6	1.6	3.0	63.90d
131	5.7	5.3	7.4	3.9	3.5	3.8	4.2	5.4	5.3	5.0	1.9	1.8	2.5	1.6	1.6	3.0	61.88d
89	5.8	4.8	8.8	3.3	2.4	2.4	4.2	5.9	5.7	5.0	2.5	2.0	2.4	1.6	1.6	3.0	61.42d
68	5.1	4.9	6.9	3.8	2.4	2.6	5.4	5.1	5.2	5.0	2.6	1.9	2.5	1.2	1.1	3.0	58.68d

points were obtained from 26 and 55 with 2.9, followed by 31 with 2.6 in fruit length. Accessions of 65, 72, 81, 89 and 115 with 2.5 points were other important peppers. The highest points were in 5, 61, 67, 110 and 123 with 2.8 in fruit width (Table 3-6).

In this study, 1000-seed-weight and number of seeds per fruit were very important<sup>[16,34]</sup> and were changed from 5.3 to 21.9 g and from 25.0 to 112.0, respectively (Table 2). In this study, 1000-seed-weight were more than previous study<sup>[20]</sup>. Numbers of seed in per fruit were parallel with

Table 6: Weighed grade of accessions with blocky fruit shape in different characters, P=0.001, n=3 (Comparisons between means were made with Fischer's LSD test within total column. Values followed by a common letter are not significantly different, LSD<sub>0.01</sub>=6.13. See materials and methods for characters)

Acc.	DFY	RFY	PDFY	FY	NRF	NF	FWT	PRFN	PRFY	FCR	FW	FL	FWD	SW	NS	RFP	WGP
123	12.8	11.3	8.5	6.9	6.6	6.4	4.2	5.8	5.8	4.0	1.8	2.3	2.8	2.8	2.8	2.3	87.23a
26	11.5	10.3	8.5	6.3	4.6	4.4	4.4	5.9	5.8	4.0	2.4	2.9	2.4	2.9	2.9	2.3	81.40ab
65	10.3	9.5	8.2	5.9	5.1	4.9	5.1	5.9	5.8	4.0	2.0	2.5	1.9	2.7	2.8	2.3	78.94bc
7	10.8	11.1	6.5	7.7	5.3	6.4	5.1	4.8	5.1	4.0	2.0	1.8	2.3	2.0	2.0	1.0	77.91b-d
90	10.6	9.5	8.1	6.0	3.7	3.6	4.4	5.8	5.6	4.0	2.8	1.7	2.6	2.8	2.8	2.3	76.30b-e
103	9.0	8.4	7.1	5.9	4.5	5.0	3.8	5.2	5.0	4.0	2.0	2.1	2.5	2.8	2.8	3.0	73.20c-f
128	9.4	8.7	8.2	5.3	4.1	4.0	3.9	5.9	5.8	4.0	2.2	1.7	2.6	2.3	2.3	1.0	71.38d-f
111	8.2	8.2	7.4	5.1	4.3	4.2	3.8	5.9	5.7	4.0	2.0	2.0	2.6	2.3	2.3	2.3	70.19ef
25	9.3	8.2	7.5	5.7	3.6	4.1	3.8	5.0	5.0	4.3	2.3	2.4	2.4	1.7	1.7	2.3	69.58f
72	6.8	6.7	6.6	4.8	2.8	3.3	4.4	4.9	4.9	4.0	2.4	2.5	2.0	1.2	1.2	2.3	60.71g
19	5.6	4.7	6.9	3.7	2.5	3.2	5.1	4.4	4.5	4.0	2.0	2.0	2.1	2.6	2.7	2.3	58.32g
132	5.5	5.0	7.8	3.2	2.6	2.6	4.2	5.6	5.4	4.0	2.0	1.8	2.7	1.6	1.5	2.3	57.94g
102	4.8	5.1	6.9	3.3	2.7	2.6	4.3	5.9	5.5	4.0	2.1	2.2	2.8	1.6	1.5	2.3	57.62g
31	3.2	2.9	5.8	2.5	1.9	2.4	5.8	4.6	4.0	4.0	1.8	2.6	2.0	2.0	2.0	2.3	49.83h

finding of previous<sup>[22]</sup> but were much more than studies of Mishra et al.<sup>[20]</sup>. Because seed number can be change by effects of genetic. While the greatest accessions were 26, 61 and 122 in 1000-seed-weight, the highest weighed point were determined in 26 and 61 in number of seeds. On the other hand, 23, 43, 45, 49, 52, 65, 66, 73, 90, 103 and 123 produced seed more than the others (Table 3-6).

Preference of fruit pungency is different in internal and external marketing. Nevertheless, when the red pepper spice says it imagines pungency. Pungency is one of the important quality attributes of chilli, *Capsicum* spp. The quality of red chilli and paprika products is based on visual and extractable red colour, pungency level and to a lesser degree, nutrition<sup>[3,35]</sup>. A consistent pungency level is important for processors and consumers. *Capsicum* pungency is the result of a genotype by environment interaction<sup>[36]</sup>. Fruit pungency were changed from low to high in this research (Table 2) and were similar in study of Engles<sup>[37]</sup> and Joshi *et al.*<sup>[4]</sup>. High pungency peppers were evaluated with high scores. Therefore 43, 53, 63, 84, 85, 103, 109, 138 and all accessions with campanulate fruit shape had high WGP.

**Evaluation of accessions based on fruit shape with Weighed Grade Method:** According to the results of weighed grade method Acc. 17 with 81.98 point was the greatest in all elongate fruit shape accessions and 122 (77.55 point), 43 (76.79 point) and 140 (75.99 point) were other successful accessions. Moreover, variance analysis showed that 1 (74.87 point), 23 (74.55 point), 117 (72.43 point) and 45 (72.37 point) was important accessions in same statistically groups (Table 3).

Accessions 52 and 135 with 81.68 and 80.94 WGP, respectively were more successful than the other all triangular fruit shape accessions followed by accession 51 with 80.15 point. Moreover, 49, 42, 67, 115, 137, 82 and 66 were other important accessions that they had over 70 point (Table 4).

Only nine accessions with campanulate fruit shape can be evaluated in this experiment. Accessions 118 had the highest weighed grade point, followed by 73 (Table 3). Also 61 and 77 was more successful than the others. Accessions 118 was the first range in almost all characters (Table 5).

Accession 123 with 87.23 weighed grade point was the greatest in all accessions with blocky fruit shape. Also 26 (81.40 point) and 65 (78.94 point) were other successful accessions. Moreover, 7 and 90 was other important accessions in this group (Table 6).

Success of any crop improvement programme is mainly dependent upon the selection of parents together with the information regarding nature and magnitude of gene effect controlling quantitative traits of economic importance. The knowledge of gene effect and combining ability not only provides information on inheritance of characters but also helps in selection of suitable parents for hybridization and development of promising hybrids for further exploitation<sup>[28]</sup>. For this purpose, a total of 115 red hot pepper accessions were evaluated based on 16 quantitative and quality characters. A different accession were successful than the others in each character. For this purpose accessions were ranged by Weighed Grade Method into four different groups with fruit shape.

As a results of this investigation, 17 with elongate fruit (Table 3), 52 with triangular fruit (Table 4), 118 with campanulate fruit shape (Table 5) and 123 with blocky fruit (Table 6) were the greatest accessions in all peppers that collected in the germplasm source of Kahramanmaras. On the other hand it appeared that 122, 43, 140, 1, 23, 117 and 45 in elongate fruit group; 135, 51, 49 and 42 in triangular fruit group; 73, 61 and 77 in campanulate fruit group; 26, 65 and 7 in blocky fruit group were promising types or lines and these selected accessions can be used for future breeding works in that they contain desirable red hot pepper characteristics for spice.

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