

Evaluation of Levante × Karakılçık durum wheat advanced lines for yield related and quality traits using principal component biplot analysis

İMREN ÇÖKEN TEKİN¹ , ALI TEKİN¹ , ZIYA DUMLUPINAR² 

¹Department of Field Crops, East Mediterranean Transitional Zone Agricultural Research Institute, Kahramanmaraş, Türkiye

²Department of Agricultural Biotechnology, Faculty of Agriculture, Kahramanmaraş Sutcu Imam University, Kahramanmaraş, Türkiye

Electronic Supplementary Material (ESM)

The authors are fully responsible for both the content and the formal aspects of the electronic supplementary material. No editorial adjustments were made.

<https://doi.org/10.17221/18/2024-CJGPB>

Table S1. The average plant height (PH), spike length (SL), No. of spikelets per spike (SNS), No. of grains per spike (GNS), grain weight per spike (GWS), and thousand kernel weight (TKW) values for years (Y), genotype (G), and $G \times Y$ interactions

		PH	SL	SNS	GNS	GWS	TKW
		(cm)				(g)	
		**	**	**	**	**	**
Years	2021–2022	78.45 ^b	8.28 ^b	19.37 ^b	55.55 ^a	1.72 ^a	30.90 ^a
	2022–2023	92.59 ^a	10.53 ^a	20.49 ^a	46.45 ^b	1.32 ^b	29.27 ^b
		**	**	**	**	**	**
Genotypes	LK1	85.16 ^{k-n}	8.29 ^u	19.60 ^{pq}	56.00 ^{cd}	1.70 ^{ef}	31.37 ^{ik}
	LK2	80.49 ^{r-u}	8.89 ^{pq}	21.35 ^{cd}	55.12 ^f	1.81 ^d	33.04 ^{fg}
	LK3	80.83 ^{rs}	9.14 ^{lm}	19.35 ^{rs}	57.75 ^b	1.93 ^c	34.72 ^d
	LK4	83.83 ^{l-o}	9.54 ^h	19.47 ^{qr}	48.00 ^o	1.24 ^w	26.12 ^{x-y}
	LK5	85.33 ^{i-l}	9.39 ⁱ	20.60 ^{ij}	57.25 ^b	1.68 ^{e-g}	29.93 ^{m-o}
	LK6	85.66 ^{h-l}	10.24 ^d	21.22 ^{de}	55.25 ^{ef}	1.60 ^{h-j}	28.74 ^{q-t}
	LK7	87.33 ^{e-j}	9.09 ^{mn}	19.97 ^{mn}	51.37 ^j	1.52 ^{lm}	31.04 ^{kl}
	LK8	80.99 ^{p-s}	9.19 ^{kl}	19.97 ^{mn}	52.50 ⁱ	1.53 ^{k-m}	29.77 ^{n-p}
	LK9	83.99 ^{l-n}	8.94 ^{op}	20.10 ^{lm}	48.62 ⁿ	1.34 ^{tu}	28.53 ^{r-t}
	LK10	80.40 ^{r-t}	9.26 ^{jk}	19.88 ^{no}	55.66 ^{d-f}	1.65 ^{f-h}	28.98 ^{q-t}
	LK11	81.73 ^{o-r}	9.06 ⁿ	19.38	50.16 ^{lm}	1.51 ^{l-n}	28.39 ^t
	LK12	77.40 ^v	10.11 ^e	20.38 ^k	55.78 ^{de}	1.41 ^{q-s}	24.01 ^{yz}
	LK13	78.40 ^{uv}	9.81 ^g	20.13 ^{lm}	51.53 ^j	1.51 ^{lm}	28.48 st
	LK14	80.06 ^{r-u}	9.56 ^h	20.76 ^{hi}	45.91 ^q	1.38 ^{r-t}	29.18 ^{p-r}
	LK15	83.06 ^{m-p}	9.96 ^f	18.88 ^u	46.78 ^p	1.28 ^{v-w}	26.38 ^{x-y}
	LK16	80.90 ^{q-s}	9.91 ^f	19.51 ^{qr}	48.91 ⁿ	1.35 ^t	26.74 ^{w-y}
	LK17	80.90 ^{q-s}	9.96 ^f	20.88 ^{gh}	49.66 ^m	1.25 ^w	24.76 ^y
	LK18	79.73 ^{s-u}	8.76 ^r	17.76 ^x	46.16 ^q	1.25 ^w	25.68 ^{x-y}
	LK19	92.42 ^c	9.28 ^j	21.81 ^{ab}	62.71 ^a	1.99 ^b	33.92 ^e
	LK20	91.42 ^c	10.63 ^a	21.94 ^a	53.21 ^h	1.61 ^{h-j}	32.41 ^{g-i}
	LK21	86.76 ^{g-k}	9.98 ^f	21.06 ^{ef}	50.96 ^{ik}	1.43 ^{p-r}	30.53 ^{lm}
	LK22	88.42 ^{d-g}	10.43 ^b	21.44 ^c	49.96 ^{lm}	1.58 ^{i-k}	33.43 ^{ef}
	LK23	94.92 ^b	10.13 ^e	21.69 ^b	50.21 ^{lm}	1.35 st	27.42 ^{u-w}
	LK24	91.76 ^c	10.13 ^e	20.81 ^{gh}	45.08 ^r	1.14 ^x	26.76 ^{v-y}
	LK25	89.42 ^{de}	10.43 ^b	21.44 ^c	52.58 ⁱ	1.51 ^{m-o}	30.61 ^{lm}
	LK26	87.26 ^{f-k}	10.33 ^c	20.94 ^{fg}	56.58 ^c	1.56 ^{j-l}	28.93 ^{q-t}
	LK27	91.92 ^c	9.28 ^j	19.19 st	47.33 ^p	1.44 ^{p-r}	32.07 ^{h-j}
	LK28	81.19 ^{p-s}	9.02 ^{no}	17.96 ^w	48.64 ⁿ	1.42 ^{p-r}	30.23 ^{mn}
	LK29	78.52 ^{t-v}	9.62 ^h	20.46 ^{jk}	50.01 ^{lm}	1.28 ^{u-w}	24.23 ^{yz}
	LK30	83.02 ^{n-q}	9.62 ^h	18.21 ^v	45.89 ^q	1.38 ^{r-t}	29.14 ^{p-s}
	LK31	87.35 ^{e-i}	8.82 ^{qr}	16.71 ^z	42.26 ^t	1.24 ^w	27.49 ^{uv}
	LK32	81.52 ^{p-s}	9.22 ^{j-l}	19.34 ^{rs}	48.51 ^{no}	1.33 ^{t-v}	27.29 ^{u-x}
	LK33	85.19 ^{j-m}	8.77 ^r	19.09 ^t	54.26 ^g	1.73 ^e	32.55 ^{gh}
	LK34	81.69 ^{o-s}	8.57 st	19.09 ^t	50.39 ^{kl}	1.64 ^{g-i}	32.28 ^{hi}
	LK35	81.69 ^{o-s}	8.62 ^s	19.59 ^{pq}	48.76 ⁿ	1.45 ^{n-q}	29.46 ^{o-q}
	LK36	73.85 ^w	9.42 ⁱ	19.71 ^{op}	52.26 ⁱ	1.35 ^t	24.95 ^y
	Karakılçık	130.99 ^a	8.54 ^t	19.71 ^p	44.11 ^s	1.69 ^{ef}	39.48 ^b
	Eminbey	87.1 ^{gh}	8.79 ^r	20.53 ^j	47.10 ^p	1.46 ^{op}	31.85 ^{ij}
	Levante	89.45 ^d	9.25 ^{jk}	20.19 ^l	51.26 ^j	1.97 ^{fg}	36.58 ^c
	Ovidio	88.78 ^{d-f}	8.24 ^u	17.27 ^y	55.46 ^{ef}	2.45 ^a	45.99 ^a
Mean		85.52	9.41	19.93	51	1.52	30.09
Genotype $\times$ year		**	**	**	**	**	**

Lowercase letters show the least significant difference (LSD, $P < 0.05$) among the genotypes; **significant at 0.01 probability levels ($P < 0.01$)

<https://doi.org/10.17221/18/2024-CJGPB>

Table S2. The average grain yield (GY), test weight (TW), protein content (PC), wet gluten content (G), starch (S), and Zeleny sedimentation (ZNS) values for years (Y), genotypes (G), and G × Y interactions

		GY (kg/m ²)	TW (kg/hL)	PC	G (%)	S	ZNS (mL)
		**	**	**	**	**	**
Year	2021–2022	0.75 ^a	74.31 ^a	17.67 ^b	38.67 ^b	61.42	73.27
	2022–2023	0.59 ^b	67.78 ^b	20.15 ^a	45.12 ^a	59.39	79.50
		**	**	**	**	**	**
Genotypes	LK1	0.71 ^{hi}	77.63 ^b	17.44 ^u	40.67 ⁿ	62.0 ⁱ	73.16 ^{vw}
	LK2	0.77 ^{ef}	75.33 ^g	16.54 ^w	35.18 ^v	63.23 ^e	69.97 ^y
	LK3	0.93 ^b	76.83 ^d	18.19 ^{pq}	40.50 ^{no}	62.10 ^{hi}	75.63 ^{no}
	LK4	0.57 ^{q-s}	71.43 ^j	17.99 ^{rs}	39.49 ^r	60.96 ^l	74.84 ^{p-r}
	LK5	0.68 ^{jk}	69.63 ^{lm}	17.94 ^s	40.14 ^{o-q}	61.80 ^j	74.41 ^{r-t}
	LK6	0.68 ^{k-m}	69.08 ^{no}	19.79 ^f	43.65 ^h	59.74 ^{pq}	79.35 ^g
	LK7	0.65 ⁿ	70.53 ^k	19.09 ^{j-l}	42.68 ^{jk}	59.96 ^o	78.93 ^{gh}
	LK8	0.66 ^{k-n}	67.28 ^s	19.59 ^g	42.69 ^{jk}	60.23 ⁿ	79.29 ^g
	LK9	0.56 ^{rs}	68.63 ^p	19.79 ^f	44.87 ^{ef}	59.17 ^s	80.31 ^f
	LK10	0.70 ^{ij}	67.67 ^{q-s}	17.96 ^s	39.82 ^{qr}	58.04 ^v	74.06 ^{tu}
	LK11	0.74 ^{fg}	67.57 ^{rs}	17.21 ^v	38.58 ^s	58.03 ^v	70.72 ^x
	LK12	0.58 ^q	63.87 ^v	19.51 ^{gh}	41.72 ^l	56.72 ^w	74.65 ^{q-s}
	LK13	0.53 ^t	68.02 ^q	18.16 ^{pq}	40.48 ^{no}	56.79 ^w	74.09 ^{tu}
	LK14	0.59 ^{pq}	65.97 ^t	19.16 ^{jk}	42.89 ^{ij}	56.74 ^w	75.72 ⁿ
	LK15	0.50 ^u	65.27 ^u	19.86 ^f	44.94 ^e	55.85 ^x	76.20 ^m
	LK16	0.58 ^q	67.92 ^{qr}	19.21 ^j	43.18 ⁱ	55.81 ^x	75.91 ^{mn}
	LK17	0.53 ^t	62.82 ^w	20.16 ^e	44.41 ^g	55.44 ^y	76.35 ^m
	LK18	0.66 ^{l-n}	70.52 ^k	17.41 ^u	38.61 ^s	58.07 ^v	70.09 ^y
	LK19	0.78 ^e	77.78 ^b	19.36 ⁱ	42.76 ^{ij}	64.26 ^b	78.56 ^{hi}
	LK20	0.57 ^{qr}	76.53 ^{de}	19.56 ^g	42.80 ^{ij}	63.81 ^c	78.31 ^{ij}
	LK21	0.73 ^{gh}	76.63 ^{de}	20.66 ^d	46.10 ^d	63.13 ^e	82.54 ^d
	LK22	0.71 ^{hi}	76.23 ^{ef}	20.61 ^d	44.63 ^{e-g}	63.52 ^d	81.03 ^e
	LK23	0.62 ^o	71.43 ^j	22.11 ^b	47.72 ^c	62.20 ^{gh}	83.54 ^c
	LK24	0.54 st	67.93 ^{qr}	23.46 ^a	49.75 ^a	60.60 ^m	86.03 ^a
	LK25	0.79 ^e	73.53 ⁱ	21.61 ^c	48.19 ^b	62.35 ^f	84.21 ^b
	LK26	0.81 ^d	74.33 ^h	20.06	44.46 ^{fg}	63.10 ^e	81.18 ^e
	LK27	0.77 ^e	75.53 ^g	19.06 ^{kl}	42.29 ^k	64.13 ^b	77.38 ^l
	LK28	0.68 ^{j-l}	70.52 ^k	18.49 ⁿ	40.00 ^q	59.65 ^q	73.65 ^{uv}
	LK29	0.58 ^{qr}	66.42 ^t	19.44 ^{hi}	40.66 ⁿ	58.54 ^u	74.64 ^s
	LK30	0.67 ^{k-n}	69.62 ^l	19.04 ^l	41.86 ^l	59.00 ^t	75.16 ^{op}
	LK31	0.68 ^{jk}	69.07 ^{n-p}	18.54 ^{mn}	42.70 ^{jk}	59.88 ^{op}	75.98 ^{mn}
	LK32	0.71 ^{hi}	66.37 ^t	18.09 ^{qr}	40.55 ^{no}	59.45 ^r	75.15 ^{o-q}
	LK33	0.65 ^{mn}	69.17 ^{mn}	18.24 ^p	41.16 ^m	59.35 ^r	75.54 ^{no}
	LK34	0.72 ^{hi}	71.27 ^j	17.44 ^u	40.42 ^{n-p}	60.18 ⁿ	73.18 ^w
	LK35	0.61 ^o	70.57 ^k	17.44 ^u	38.94 ^s	60.01 ^o	73.03 ^w
	LK36	0.61 ^{op}	71.12 ^j	17.79 ^t	36.73 ^t	59.89 ^{op}	74.10 ^{tu}
	Karakılçık	0.47 ^v	76.13 ^f	18.59 ^m	43.85 ^h	61.52 ^k	77.94 ^{jk}
	Eminbey	0.62 ^o	68.74 ^{op}	18.34 ^o	40.05 ^q	62.28 ^{fg}	77.90 ^k
	Levante	0.87 ^c	77.23 ^c	16.23 ^x	35.60 ^u	64.41 ^a	68.41 ^z
	Ovidio	1.00 ^a	79.70 ^a	17.24 ^v	40.10 ^{pq}	64.17 ^b	74.31 st
Mean		0.67	71.05	18.91	41.90	60.40	76.39
Genotype × year		**	**	**	**	**	**

Lowercase letters show the least significant difference (LSD, $P < 0.05$) among the genotypes; **significant at 0.01 probability levels ($P < 0.01$)

4 Table S3. Spearman's correlation matrix of investigated traits

	PH	SL	SNS	GNS	GWS	TKW	GY	TW	PC	G	S	ZNS
PH	1	-0.188 ^{ns}	-0.115 ^{ns}	-0.236 ^{ns}	0.055 ^{ns}	0.240 ^{ns}	-0.103 ^{ns}	-0.010 ^{ns}	0.016 ^{ns}	0.170 ^{ns}	0.055 ^{ns}	0.100 ^{ns}
SL	-0.188 ^{ns}	1	0.534**	-0.236 ^{ns}	-0.351*	-0.546**	-0.365*	-0.481**	0.016**	0.524**	-0.721**	0.499**
SNS	-0.115 ^{ns}	0.534**	1	0.312 ^{ns}	0.106 ^{ns}	-0.106 ^{ns}	-0.258 ^{ns}	-0.298 ^{ns}	0.346*	0.195 ^{ns}	-0.325*	0.284 ^{ns}
GNS	-0.236 ^{ns}	-0.236 ^{ns}	0.312 ^{ns}	1	0.699**	0.250 ^{ns}	0.403**	0.189 ^{ns}	-0.285 ^{ns}	-0.300 ^{ns}	0.217 ^{ns}	-0.251 ^{ns}
GWS	0.055 ^{ns}	-0.351*	0.106 ^{ns}	0.699**	1	0.818**	0.456**	0.517**	-0.514**	-0.387*	0.565**	-0.381*
TKW	0.240 ^{ns}	-0.546**	-0.106 ^{ns}	0.250 ^{ns}	0.818**	1	0.425**	0.636**	-0.550**	-0.389*	0.645**	-0.391*
GY	-0.103 ^{ns}	-0.365*	-0.258 ^{ns}	0.403**	0.456**	0.425**	1	0.452**	-0.515**	-0.459**	0.552**	-0.511**
TW	-0.010 ^{ns}	-0.481**	-0.298 ^{ns}	0.189 ^{ns}	0.517**	0.636**	0.452**	1	-0.687**	-0.575**	0.712**	-0.666**
PC	0.016 ^{ns}	0.016**	0.346*	-0.285 ^{ns}	-0.514**	-0.550**	-0.515**	-0.687**	1	0.920**	-0.921**	0.891**
G	0.170 ^{ns}	0.524**	0.195 ^{ns}	-0.300 ^{ns}	-0.387*	-0.389*	-0.459**	-0.575**	0.920**	1	-0.831**	0.893**
S	0.055 ^{ns}	-0.721**	-0.325*	0.217 ^{ns}	0.565**	0.645**	0.552**	0.712**	-0.921**	-0.831**	1	-0.796**
ZNS	0.100 ^{ns}	0.499**	0.284 ^{ns}	-0.251 ^{ns}	-0.381*	-0.391*	-0.511**	-0.666**	0.891**	0.893**	-0.796**	1

PH – plant height; SL – spike length; SNS – No. of spikelets per spike; GNS – No. of grains per spike; GWS – grain weight per spike; TKW – thousand kernel weight; GY – grain yield; TW – test weight; PC – protein content; G – wet gluten content; S – starch; ZNS – Zeleny sedimentation; *significant at 0.05 probability levels ($P < 0.05$); **significant at 0.01 probability levels ($P < 0.01$); ^{ns}not significant