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Supplementary Material

Variation in a worldwide collection of fennel (*Foeniculum vulgare* var. *vulgare*)

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Table S1. Analysis of variance for agro-morphological traits and essential oil content of fennel genotypes evaluated in four years from 2015 to 2018.

Sources of variation	df	Mean square												
		Days to flowering	Days to maturity	Plant height	Plant fresh weight	Plant dry weight	Number of umbels per plant	Number of umbelet per umbel	Number of seeds per umbelet	Seed yield	1000-seeds weight	Harvest index	Seed essential oil content	Essential oil yield
Replication	1	25.80 ^{ns}	6.71 ^{ns}	31.26 ^{ns}	30541.04 [*]	2849.85 [*]	284.92 ^{**}	30.86 ^{**}	33.23 [*]	4.35 ^{ns}	0.20 [*]	135.19 ^{**}	0.84 ^{**}	0.0002 ^{ns}
Genotype	32	1090.82 ^{**}	412.30 ^{**}	3352.34 ^{**}	101013.37 ^{**}	9270.97 ^{**}	614.15 ^{**}	59.62 ^{**}	150.17 ^{**}	551.79 ^{**}	2.41 ^{**}	421.34 ^{**}	4.68 ^{**}	0.44 ^{**}
Rep×Gen	32	16.56 ^{**}	8.29 ^{**}	57.02 ^{**}	8745.92 ^{ns}	841.84 [*]	93.17 ^{**}	12.61 ^{**}	18.30 ^{**}	93.01 ^{**}	0.06 ^{**}	59.86 ^{**}	0.10 ^{ns}	0.09 ^{**}
Year	3	2244.50 ^{**}	16317.94 ^{**}	50162.75 ^{**}	2671476.53 ^{**}	113585.42 ^{**}	11201.58 ^{**}	54.37 ^{**}	833.31 ^{**}	124.20 ^{**}	6.50 ^{**}	2578.68 ^{**}	5.69 ^{**}	0.30 ^{**}
Gen×Year	96	58.20 ^{**}	15.42 ^{**}	211.57 ^{**}	45844.97 ^{**}	4459.24 ^{**}	426.80 ^{**}	27.13 ^{**}	60.44 ^{**}	203.09 ^{**}	0.19 ^{**}	149.34 ^{**}	1.04 ^{**}	0.18 ^{**}
Error	99	7.93	2.32	29.50	6131.59	482.82	38.76	1.50	6.34	8.96	0.03	15.99	0.11	0.01

ns: non-significant
*: Significant at 5% level of probability
**: Significant at 1% level of probability

Gen= Genotype
Y= Year

Table S2. Analysis of variance for important essential oil components of fennel genotypes evaluated in two years of 2015 and 2016.

Sources of variation	df	Mean square			
		Limonene	Fenchone	Estragole	trans-Anethole
Replication	1	0.37 ^{**}	2.76 ^{**}	58.18 ^{**}	0.39 ^{**}
Genotype	32	2.28 ^{**}	16.11 ^{**}	71.78 ^{**}	62.25 ^{**}
Rep×Gen	32	0.001 ^{**}	0.002 ^{ns}	0.17 [*]	0.00006 ^{ns}
Year	1	0.05 ^{**}	111.08 ^{**}	1297.85 ^{**}	345.18 ^{**}
Gen×Year	32	0.81 ^{**}	7.33 ^{**}	27.91 ^{**}	27.22 ^{**}
Error	33	0.0006	0.001	0.07	0.00008

ns: non-significant
 *: Significant at 5% level of probability
 **: Significant at 1% level of probability

Gen= Genotype
 Y= Year

Table S3. Means of agro-morphological characters and essential oil content of five groups of fennel genotypes evaluated in four years from 2015 to 2018.

Treat	Means				
	Group 1	Group 2	Group 3	Group 4	Group 5
1- Days to flowering	57.37 ^c	57.75 ^c	82.89 ^a	70.84 ^b	75.71 ^{ab}
2- Days to maturity	154.30 ^c	156.00 ^{bc}	166.26 ^a	163.24 ^{ab}	167.55 ^a
3- Plant height (cm)	98.93 ^b	95.25 ^c	143.78 ^a	120.28 ^b	146.43 ^a
4- Plant fresh weight (g/plant)	324.47 ^b	102.49 ^c	278.31 ^b	283.88 ^b	500.50 ^a
5- Plant dry weight (g/plant)	84.37 ^b	25.53 ^c	69.37 ^b	91.19 ^b	158.64 ^a
6- Number of umbels per plant	23.64 ^b	2.85 ^c	21.64 ^b	29.91 ^b	47.70 ^a
7- Number of umbelets per umbel	10.94 ^a	13.80 ^a	11.88 ^a	13.01 ^a	13.79 ^a
8- Number of seeds per umbelet	27.33 ^a	18.00 ^b	26.51 ^a	25.52 ^{ab}	31.23 ^a
9- Seed yield (g/plant)	10.48 ^b	2.22 ^c	7.89 ^{bc}	21.83 ^a	27.70 ^a
10- 1000-seeds weight (g)	3.47 ^a	1.62 ^c	2.52 ^b	3.17 ^{ab}	2.69 ^b
11- Harvest index	12.93 ^{bc}	8.71 ^c	11.56 ^{bc}	24.59 ^a	18.06 ^{ab}
12- Essential oil content (%)	2.14 ^b	2.27 ^b	3.76 ^a	2.87 ^{ab}	2.99 ^{ab}
13- Essential oil yield (g/plant)	0.22 ^{bc}	0.05 ^c	0.53 ^{abc}	0.62 ^{ab}	0.79 ^a

Table S4. Result of principal components analysis using agro-morphological traits and essential oil content of 33 fennel genotypes evaluated during 2015 to 2018.

Component Number	Eigenvalue	Percent of Variance	Cumulative Percentage
1	4.15	47.93	47.93
2	3.42	39.55	87.48
3	1.51	3.49	90.97
4	1.17	2.71	93.68
5	1.00	2.31	96.00
6	0.49	1.15	97.15
7	0.39	0.91	98.06
8	0.30	0.71	98.78
9	0.22	0.52	99.31
10	0.14	0.33	99.65
11	0.09	0.21	99.86
12	0.04	0.10	99.96
13	0.01	0.03	100

Table S5. Means of important essential oil components of five groups of fennel genotypes evaluated in two years of 2015 and 2016.

Treat	Means				
	Group 1	Group 2	Group 3	Group 4	Group 5
1- Limonene	1.60 ^{bc}	2.38 ^{ab}	2.64 ^a	0.83 ^c	1.71 ^b
2- Fenchone	12.50 ^c	11.01 ^{cd}	14.39 ^b	17.12 ^a	10.89 ^d
3- Estragole	19.24 ^a	16.11 ^a	12.14 ^b	9.55 ^{bc}	6.13 ^c
4- trans-Anethole	64.92 ^c	69.93 ^b	68.62 ^b	69.90 ^b	78.16 ^a

Table S6. Result of principal components analysis using essential oil components in 33 fennel genotypes evaluated in two years of 2015 and 2016.

Component Number	Eigenvalue	Percent of Variance	Cumulative Percentage
1	1.79	44.89	44.89
2	1.25	31.40	76.29
3	0.89	22.43	98.73
4	0.05	1.26	100.00

Table S7. Chemical composition of the fennel essential oil identified by GC mass analysis

	Component	Molecular formula	Retention time (min)	Retention index	Retention index based on literature
1	Limonene	C ₁₀ H ₁₆	4.94	1004.92	1009 (Lima et al. 2005)
2	Fenchone	C ₁₀ H ₁₆ O	6.48	1065.17	1065 (Takeoka et al. 2010)
3	Estragole	C ₁₀ H ₁₂ O	9.52	1169.78	1170 (Riu-Aumatell et al. 2004)
4	trans-Anethole	C ₁₀ H ₁₂ O	12.84	1273.68	1273 (Fakhari et al. 2005)