Variety Registration

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Oil Sunflower (*Helianthus annuus* L.) Variety "1931 CL"

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ABSTRACT

As a result of the sunflower breeding studies carried out at the Trakya Agricultural Research Institute Directorate, Edirne location, the sunflower variety was developed and submitted for registration. In the registration trials, yield, oil rate, oil yield, imazamox (40g/l) resistant and morphological observations as a result, it qualified to be a variety and was registered in 2024 with the name "1931 CL". As a result of sunflower registration yield trials established in different regions of Türkiye, the average yield of "1931 CL" variety was 2306 kg/ha, while the highest yield value was 3486 kg/ha grain yield. According to the results of the experiment, flowering period of the varieties was 54-74 days, physiological maturity 88-106 days, plant height was 143-186 cm, and head diameter was determined in the range of 13-20,3 cm. In terms of technological characteristics, oil ratio was determined in the range of 36-42,4%. In phytotoxicity observations, although the plants were light green (2) and yellow green (3) when the first application was done one week after the first application, it was observed that the harmful effect of imazamox (40 g/l) completely disappeared in the second week. Certified seed production of our "1931 CL" sunflower variety; which was registered in 2024, was produced as of 2025 and offered to our farmers.

Keywords: Sunflower, yield, oil rate, imazamox

Introduction

Sunflower (*Helianthus annuus* L.) belongs to the *Helianthus* genus of the Asteraceae family, which includes 51 species and 19 subspecies. A large portion of *Helianthus* species are ornamental plants. The agriculturally important varieties are *Helianthus annuus* L. (sunflower) and *Helianthus tuberosus* (Jerusalem artichoke) (Meral, 2019). Sunflower species have a basic chromosome number of n=17, and are found in diploid, tetraploid, and hexaploid structures and those containing more than two ploidy levels (Arıoğlu, 2007).

Sunflower, the most widely cultivated oilseed crop in our country, is one of the most important oilseed plants. Due to its wide adaptability, it is grown in many parts of our country under both irrigated and dryland conditions. However, there are many biotic and abiotic factors that affect yield and quality characteristics in its cultivation. The most important biotic factors are disease, weeds, and the parasitic plant Orobanche (*Orobanche cumana*).

Our aim in breeding studies is to determine high yielding, high market value, good quality, IMI group herbicidies tolerant/resistant varieties or variety candidates of sunflower. 1931 CL sunflower variety is an hybrid IMI group herbicidies tolerance variety registered for this purpose.

Materials and Methods

1931 CL sunflower (*Helianthus annuus*) variety is a hybrid which developed by hybridization method and it is an outcome of the national sunflower breeding projects conducted by Trakya Agricultural Research Institute (TARI). 1931 CL sunflower variety was registered by TARI and due to its high adaptations

to the different conditions across Türkiye. 1931 CL sunflower variety was bred from IMI 1091 A (CMS line) and IMI 540 R (Restorer line) materials in 2019 by using hybridization breeding method. It was registered as the variety name "1931 CL" in 2024 and offered to farmers. IMI 1091 A is a high oleic type, downy mildew-tolerant, cytoplasmic male sterile line (CMS). IMI 540 R (Restorer line) is linoleic type and tolerant to broomrape and downy mildew. Both lines were developed within the national plant breeding project of TARI.

Field trials were conducted in eight different locations in 2022 and 2023. Experimental design and agricultural practices were applied according to the instructions created by Variety Registration and Seed Certification Center Directorate (TTSM, 2001). Randomized complete block design was used with four replications and four rows. Rows were 7.5 m long, and plant spacing was 70 × 30 cm. Total planting area of each plots was 21 m^2. Two rows of each plot located in the middle were harvested and total harvesting area was 9,66 m^2. There were no irrigations in all locations, 8 kg/da N and 5 kg/da P_2O_5 was used for fertilization In the trials, imazamox (40g/l) application dose was 1,25 L/ha and it applied at the 4-6 or 6-8 leaves stage of sunflower. After the application, first phytotoxicity observations were taken one week later, and the second took place two weeks later. A 1-9 scale was used for observations. 1-9 scale: 1 = no damage, 2 = light green, 3 = yellow-green, 4 = yellow, 5 = reduced growth, 6 = some plants with deformities, 7 = many plants with deformities, 8 = some dead plants, 9 = all plants dead.

Resistance to broomrape and downy mildew were evaluated at TARI. The resistance to broomrape was evaluated in pots artificially infected soil. Broomrape seeds were collected from several locations in the Thrace region. In the climate chamber, each plastic cups contained different sunflower genotypes and mixed soil with broomrape seeds (1-2 g). 35 days after planting, the plants in cups were removed, the roots were washed, the tubers of the rootstock were counted and the degree of resistance was determined by measuring frequency of infection, intensity of infection and levels of aggression. Genotypes were evaluated as susceptible, tolerant and resistant according to results (Evci et al., 2011a). In terms of downy mildew, inoculation method was also used. Seeds were germinated in climate chamber for 2 days at 26°C. Germinated seeds (with 0,5-1 cm rootlets) were infected by the bulk races of downy mildew collected from the region in climate chamber (15°C, 60 % moisture, 12h/12h and 1 week). Infected plants were observed and scored according to the sporulation on the plants (Evci et al., 2011b).

Analysis of variance for each locations and combined analysis of variance across locations were done by using SAS 9.0. sofware. Least Significant Difference (LSD) test at 5% probability level was used for the comparison of hybrids performances.

Results and Discussion

In the registration trials, due to the data of yield, oil rate, oil yield, imazamox (40g/l) resistance and morphological observations, 1931 CL was qualified to be a variety and was registered in 2024 with the name "1931 CL". The average yield of "1931 CL" variety was 2306 kg/ha, while the highest yield value was 3486 kg/ha grain yield. Average yield across the locations (Table 4) shows that 1931 CL is ranked 4th and 2.5% behind the average of standard varieties (2365 kg/ha). It is also not significantly different than two of the check varieties. Grain yield was reported as 639-4247 kg/ha by Kaya et al. (2009), 325 kg/ha-1352 kg/ha by Kılıç (2010), 438 kg/ha-3569 kg/ha by Öz et al. (2011), and 1438-1938 kg/ha by Cabar (2024). Yılmaz and Kınay (2015) explained that the different values found in grain yield vary depending on the variety characteristics, environmental conditions, and cultivation technique. Our findings are similar to those obtained in different studies.

When the Table 5 is examined in terms of oil content, the 1931 CL variety was found to have the same oil content as the LG 5542 CL standard variety in the Tekirdağ-Muratlı location. It had a higher oil content than the same standard variety in the Edirne-Sarayakpınar location and the TR 2242 CL standard variety in the Edirne-Havsa location. When the overall averages are examined, it is in the same statistical group as the LG 5542 CL standard variety. In terms of oil yield during the 2022 (Table 5) production season, the 1931 CL variety was found to have a higher oil yield than the TR 2242 CL standard variety in the Tekirdağ-Muratlı and Tekirdağ-Ergene locations, as well as in the Edirne-Sarayakpınar and Edirne-Havsa locations. Furthermore, it had a higher oil yield than the LG 5542 CL standard variety in the Edirne-Havsa and Edirne-Center locations. Considering the overall average, it was in the same statistical group as the LG 5542 CL and TR 2242 CL standard varieties. In the 2023 production season (Table 6), the 1931 CL variety was found to have a higher oil content than the LG 5542 CL standard variety in the Edirne-Central location. When the overall averages were examined, it was in the same statistical group as the LG 5542 CL standard variety. 1931 CL variety has a higher oil yield than the Başaran CL and LG 5542 CL standard varieties in the Edirne-Central location (Table 6). Considering

the overall averages, the 1931 CL variety was in the same statistical group as the standard varieties P64LC108, LG 5542 CL, and TR 2242 CL. Kaya et al. (2009) reported oil content as 38.1%-53.4%, Kılıç (2010) as 41.2%-48.3%, Öz et al. (2011) as 36.3%-37.6%, Poyraz (2012) as 40.36%-45.05%, and Cabar (2024) as 33.0%-43.9%. The varying values found in oil content measurements can be attributed to the fact that oil content is a quantitative characteristic. In sunflowers, oil content varies depending on climate and soil structure, variety/line characteristics, harvest maturity time, and cultural practices (Kılıç, 2010).

According to the results of the experiment, flowering period of the varieties was 54-74 days, physiological maturity 88-106 days, plant height was 143-186 cm, and head diameter was determined in the range of 13-20,3 cm. In terms of technological characteristics, oil ratio was determined in the range of 36-42,4%. In different studies, the flowering period of the varieties was 59-86 days according to Kaya et al. (2009), 59.2-70.0 Kılıç (2010) and 55.8-64.3 Cabar (2024); the number of days to physiological maturity was days according to 94.0-107.7 Kılıç (2010), 87.8-89.9 Poyraz (2012) and 95.5-106.8 days according to Cabar (2024). The differing values observed in the number of days to flowering period and physiological maturity are thought to be due to the climate during the plant's growing period, the genetic characteristics of the varieties, and ecological differences. Plant height was reported as 108.7-177.5 cm Kılıç (2010), 145.0-158.3 cm Poyraz (2012), and 110.0-152.2 cm by Cabar (2024). Kaya et al. (2009) reported that they found the head diameter to be Kaya et al. (2009) 10-24 cm, Kılıç (2010) 12.2-20.7 cm, Poyraz (2012) 11.6-19.7 cm, and Cabar (2024) 12.5-14.7 cm. Cabar (2024) reported that the different values found in head diameter measurements plant height may be due to climatic characteristics during the plant's growing period, planting density, soil structure, cultural practices, genetic characteristics of varieties, and ecological differences.

In phytotoxicity observations (Table 7, Table 8), although the plants were light green (2) and yellow green (3) when the first application was done one week after the first application, it was observed that the harmful effect of imazamox (40 g/l) completely disappeared in the second week.

Conclusions

Despite sunflower is the most widely cultivated, produced, and consumed oilseed crop in Türkiye, domestic seed companies have not yet achieved a comparable level of capacity in seed production and cultivar breeding. Trakya Agricultural Research Institute, operating under the Ministry of Agriculture and Forestry, serves as the national coordinating institute for sunflower breeding and cultivation activities in Türkiye. Owing to its long-established hybrid breeding program, variety development and registration processes have progressed efficiently over the years. The registered sunflower variety 1931 CL is one of the outcomes of this breeding program. Through this variety, the Institute has reached not only sunflower growers in the Trakya region but also farmers in various sunflower-producing areas across Türkiye. In recent years, the cultivated area of sunflower varieties developed by the Institute has shown a consistent increase.

Figure 1. 1931 CL Sunflower (*Helianthus annuus* L.) (Original).

Table 1. 1931 CL some biological, morphological and technological characters.

Registration year	2024	
Place and year of breeding	Edirne-2019	
The organization that owns the variety	The Trakya Agricultural Research Institute Directorate Edirne, Türkiye	
Breeding organization	Trakya Agricultural Research Institute Directorate	
Breeding method	Pedigree	
Biological properties	Number of days to flowering	65-74
	Number of days to physiological maturity	88-106
	Mildew resistant	High tolerance
	Broomrape resistant	High tolerance
Morphological features	Plant height (cm)	145-186
	Head diameter (cm)	16-20
	Self pollination (1-5)*	4-5
	Head center seed filling (1-5)**	4-5
	Uniformity (1-5)***	1-2
Technological features	Thousand seed weight(g)	32,8-52,8
	Hectoliter weight (g/lt)	363-424,5
	Oil rate (%)	40-42
Agricultural properties	In registration trials;	
	Average yield (kg/ha)	2300
	Highest yield (kg/ha)	3490
Herbicide resistance	Yes	Imazamox (40 g/l)
Places where registration trials are carried out	Tekirdağ (Muratlı, Ergene) 2 location Edirne (Center, Hasköy, Havsa, Sarayakpınar) 4 location Kırklareli (Babaeski, Ahmetbey) 2 location	

(*) 1... very weak 2. weak 3. medium 4. good 5... very good.

(**) 1… wide space 5... narrow space.

(***) 1 = very uniform 2 = uniform 3 = medium 4 = heterogeneous 5 = very heterogeneous.

Table 2. Yield Results of 2022 IMI Group Sunflower Agricultural Values Measurement Trials (kg/ha).

Varieties	**Tekirdağ (Muratlı)**	**Tekirdağ (Ergene)**	**Edirne (Hasköy)**	**Edirne (S.akpınar)**	**Edirne (Havsa)**	**Edirne (Merkez)**	**Average**
1- P64LC108 (c)	3152 ab	2573 a	2572 ab	3977 a	2196 c	2526	2833 a
2- LG 5542 CL (c)	3131 ab	2243 b	2566 ab	3948 ab	2376 abc	2375	2773 ab
3- Başaran CL (c)	2709 c	2031 cd	2758 a	3731 abc	2333 bc	2713	2713 ab
4-Sy Paladium	2807 abc	2190 bc	2309 b	3464 bc	2387 abc	2704	2643 bc
5- 1931 CL	2753 bc	1886 de	2510 ab	3486 abc	2609 ab	2602	2641 bc
6- 1916 CL	2685 c	1839 de	2276 b	3325 c	2702 a	2375	2534 cd
7- SUN 2259 CL	2734 c	1945 d	2318 b	3532 abc	2136 c	2540	2534 cd
8- TR 2242 CL	2504 c	1721 e	2381 ab	3304 c	2401 abc	2609	2487 d
F	*	**	*	*	*	ns	**
CV (%)	9.4	6.5	10.8	9.5	10.0	8.4	9.5
LSD (kg)	389	197	389	501	352	-	143

*: p<0.05 level, **: p<0.01 level, ns: not significant

Note 1: Values are taken from Variety Registration and Seed Certification Center Directorate, 2024 IMI type sunflower variety registration report (TTSM, 2024). LSD value of Edirne Merkez is absent because of F test were found not significant.

Table 3. Yield Results of 2023 IMI Group Sunflower Agricultural Values Measurement Trials (kg/ha).

Varieties	Kırklareli (Babaeski)	Edirne (Merkez)	Kırklareli (Ahmetbey)	Average
1- LG 5542 CL (c)	2631	1395	1194	1740
2- P64LC108 (c)	2490	1432	1285	1736
3- TR 2242 CL (c)	2459	1384	1123	1656
4- Başaran CL (c)	2580	1093	1244	1639
5- 1931 CL	2275	1443	1192	1636
6- Hysun 180 IT	2525	1089	1040	1551
7- 1916 CL	2222	1297	1054	1524
8- Acsun	2416	1077	1050	1514
F	ns	ns	ns	ns
CV (%)	11,1	17,8	16,8	14,3
LSD (kg)	-	-	-	-

ns: not significant

Note 1: Values are taken from Variety Registration and Seed Certification Center Directorate, 2024 IMI type sunflower variety registration report (TTSM, 2024). LSD values are absent because of F tests of each location were found not significant.

Table 4. Yield Results of 2022-2023 IMI Group Sunflower Agricultural Values Measurement Trials (kg/ha).

Varieties	Tekirdağ		Kırklareli		Edirne					Average
	Ergene	Muratlı	Babaeski	Ahmetbey	Merkez		Havsa	S.akpınar	Hasköy	
	2022	**2023**	**2023**	**2023**	**2022**	**2023**	**2022**	**2022**	**2022**	
1-P64LC108 (c)	2573	3152	2490	1285	2526	1432	2196	3977	2572	2467 a
2-LG 5542 CL (c)	2243	3131	2631	1194	2375	1395	2376	3948	2566	2429 a
3-Başaran CL (c)	2031	2709	2580	1244	2713	1093	2333	3731	2758	2355 ab
4-TR 2242 CL (c)	1721	2504	2459	1123	2609	1384	2401	3304	2381	2210 c
5-1931 CL	1886	2753	2275	1192	2602	1443	2609	3486	2510	2306 bc
6-1916 CL	1839	2685	2222	1054	2375	1297	2702	3325	2276	2197 c
F										**
CV (%)										10.7
LSD (kg)										116

**: p<0.01 level

Note 1: Values are taken from Variety Registration and Seed Certification Center Directorate, 2024 IMI type sunflower variety registration report (TTSM, 2024).

Table 5. Oil Rate (%) and Oil Yield (kg/ha) Results of 2022 IMI Group Sunflower Agricultural Values Measurement Trials.

Varieties	Tekirdağ (Muratlı, Kırkkepenekli)		Tekirdağ (Ergene, Vakıflar)		Edirne (Hasköy)		Edirne (Sarayakpınar)		Edirne (Havsa, Habiller)		Edirne (Merkez)		Average		Oil Rank
	Oil Rate (%)	Oil Yield (kg/ha)	Oil Rate (%)	Oil Yield (kg/ha)	Oil Rate (%)	Oil Yield (kg/ha)	Oil Rate (%)	Oil Yield (kg/ha)	Oil Rate (%)	Oil Yield (kg/ha)	Oil Rate (%)	Oil Yield (kg/ha)	Oil Rate (%)	Oil Yield (kg/ha)	
Başaran CL (st)	44.3	1200	41.4	841	48.7	1343	49.4	1843	49.4	1153	46.5	1262	46.6 a	1274 a	**1**
P64LC108 (st)	41.1	1295	41.4	1065	45.2	1163	41.2	1639	47.3	1039	44.5	1124	43.5 b	1221 a	**2**
LG 5542 CL (st)	37.8	1184	38.4	860	42.9	1101	40.2	1587	41.8	993	40.1	952	40.2 cd	1113 b	**3**
TR 2242 CL (st)	40.8	1022	37.4	643	45.6	1086	42.3	1398	39.4	946	42.9	1119	41.4 c	1036 b	**8**
SY PALADIUM	37.9	1064	37.0	809	43.4	1002	41.1	1424	43.1	1029	38.9	1052	40.2 cd	1063 b	**4**
SUN 2259 CL	39.8	1088	37.4	726	43.0	997	43.0	1519	44.5	951	42.7	1085	41.7 c	1061 b	**5**
1931 CL	37.8	1041	36.0	679	42.4	1064	40.6	1415	40.7	1062	40.0	1041	39.6 d	1050 b	**6**
1916 CL	39.4	1058	39.7	729	42.8	974	42.1	1400	40.4	1092	41.3	981	40.9 cd	1039 b	**7**
F													**	**	
CV %													3.4	7.1	
LSD													1.7	92	

**: p<0.01 level

Note 1: Values are taken from Variety Registration and Seed Certification Center Directorate, 2024 IMI type sunflower variety registration report (TTSM, 2024).

Table 6. Oil Rate (%) and Oil Yield (kg/ha) Results of 2023 IMI Group Sunflower Agricultural Values Measurement Trials.

Varieties	Kırklareli (Babaeski)		Edirne (Merkez)		Kırklareli (Ahmetbey)		Average		Oil Rank
	Oil Rate (%)	Oil Yield (kg/ha)	Oil Rate (%)	Oil Rate (%)	Oil Rate (%)	Oil Rate (%)	Oil Rate (%)	Oil Yield (kg/ha)	
Başaran CL (st)	45.3	1169	47.0	51.3	45.5	56.6	45.9 a	749 a	1
P64LC108 (st)	43.8	1091	41.6	59.6	41.5	53.3	42.3 bc	740 ab	2
LG 5542 CL (st)	41.6	1094	38.1	53.2	43.5	51.9	41.1 bcd	715 ab	3
TR 2242CL (st)	42.6	1048	40.4	55.9	44.8	50.3	42.6 b	703 abc	4
Acsun	44.4	1073	47.5	51.2	45.6	47.9	45.8 a	688 abc	5
1931 CL	38.6	878	38.3	55.2	41.1	49.0	39.3 d	640 bc	6
Hysun 180 IT	40.7	1028	39.3	42.8	43.4	45.1	41.1 bcd	636 bc	7
1916 CL	39.1	869	39.2	50.9	40.8	43.0	39.7 cd	603 c	8
F							**	**ns**	
CV %							3.8	8.7	
LSD							2.8	105	

**: p<0.01 level, ns: not significant

Note 1: Values are taken from Variety Registration and Seed Certification Center Directorate, 2024 IMI type sunflower variety registration report (TTSM, 2024).

Table 7. Phytotoxicity Effects of Imidazolinone Group Herbicide-Resistant Sunflower Varieties: 2022 Observation Results (4-8 Leaf Stage).

Tekirdağ (Muratlı - Kırkkepenekli)	Plant Date: 12.05.2022		Herbicide Application: 14.06.2022						
					Varieties 1250 cc/ha				
	1st Week Observation: 21.06.2022	LG 5542 CL (st)	SUN 2259 CL	P64LC108 (st)	TR 2242 CL (st)	Başaran CL (st)	SY PALADIUM	1931 CL	1916 CL
	A	3	3	4	3	3	2	3	3
	B	3	3	4	3	3	2	3	3
	C	3	3	4	3	3	2	3	3
	D	3	3	4	3	3	2	3	3
	2nd Week Observation: 28.06.2022				**Varieties 1250 cc/ha**				
	A	1	1	2	1	1	1	1	1
	B	1	1	2	1	1	1	1	1
	C	1	1	2	1	1	1	1	1
	D	1	1	2	1	1	1	1	1
Edirne (Sarayakpınar)	Plant Date: 31.03.2022		Herbicide Application: 06.05.2022						
	1st Week Observation: 13.05.2022				**Varieties 1250 cc/ha**				
	A	2	3	3	2	2	3	2	2
	B	3	2	2	2	3	2	2	3
	C	2	2	2	2	2	2	3	3
	D	3	2	2	3	3	2	3	2
	2nd Week Observation: 20.05.2022				**Varieties 1250 cc/ha**				
	A	1	2	2	2	1	2	1	1
	B	2	1	1	1	2	1	1	2
	C	1	1	1	1	1	1	2	2
	D	1	1	1	2	2	2	2	1

1-9 scale: 1 = no damage, 2 = light green, 3 = yellow-green, 4 = yellow, 5 = reduced growth, 6 = some plants with deformities, 7 = many plants with deformities, 8 = some dead plants, 9 = all plants dead

Note 1: Values are taken from Variety Registration and Seed Certification Center Directorate, 2024 IMI type sunflower variety registration report (TTSM, 2024).

Table 8. Phytotoxicity Effects of Imidazolinone Group Herbicide-Resistant Sunflower Varieties: 2023 Observation Results (4-8 Leaf Stage).

Kırklareli (Babaeski)	Plant Date: 16.05.2023		Herbicide Application:: 09.06.2023						
					Varieties 1250 cc/ha				
	1st Week Observation: 16.06.2023	Başaran CL (st)	1931 CL	1916 CL	P64LC108 (st)	Acsun	LG 5542 CL (st)	Hysun 180 IT	TR 2242CL (st)
	A	3	3	3	3	3	3	3	2
	B	3	2	2	2	2	2	2	2
	C	2	3	2	2	2	3	2	3
	D	2	2	3	2	3	2	3	2
	2nd Week Observation: 23.06.2023				**Varieties 1250 cc/ha**				
	A	1	2	2	1	1	1	2	1
	B	2	1	1	1	1	1	1	1
	C	1	1	1	1	1	2	1	1
	D	1	1	1	1	1	1	1	1
Kırklareli (Ahmetbey)	Plant Date: 16.05.2023		Herbicide Application: 17.06.2023						
	1st Week Observation: 24.06.2023				**Varieties 1250 cc/ha**				
	A	1	1	1	1	1	2	2	1
	B	1	2	1	1	1	2	2	1
	C	1	1	2	1	1	2	2	1
	D	1	1	2	1	2	2	2	1
	2nd Week Observation: 31.06.2023				**Varieties 1250 cc/ha**				
	A	1	1	1	1	1	1	1	1
	B	1	1	1	1	1	1	1	1
	C	1	1	1	1	1	1	1	1
	D	1	1	1	1	1	1	1	1

1-9 scale: 1 = no damage, 2 = light green, 3 = yellow-green, 4 = yellow, 5 = reduced growth, 6 = some plants with deformities, 7 = many plants with deformities, 8 = some dead plants, 9 = all plants dead

Note 1: Values are taken from Variety Registration and Seed Certification Center Directorate, 2024 IMI type sunflower variety registration report (TTSM, 2024).

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