EFFECTS OF CHEMICAL, ORGANIC AND ORGANOMINERAL FERTILIZER APPLICATIONS ON YIELD, AND QUALITY PARAMETERS IN SUSTAINABLE CONFECTIONERY SUNFLOWER (*HELIANTHUS ANNUUS* L.) CULTIVATION UNDER THE ECOLOGICAL CONDITIONS OF KAHRAMANMARAŞ, TÜRKIYE

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(Received 13th Jun 2025; accepted 15th Oct 2025)

Abstract. The research was carried out in Kahramanmaraş Sütçü İmam University Field Crops trial area in 2021 and 2022 with 3 replications, according to a randomized complete block design in order to determine the effects of chemical, organic, and organomineral fertilizer applications on yield and some quality parameters in sustainable confectionery sunflower cultivation, under the ecological conditions of Kahramanmaraş. The "İnegöl Alası" confectionery sunflower variety was used as the material in the study. The highest number of filled seeds per head was obtained from the vermicompost + chemical fertilizer application with 592.79. The highest thousand-seed weight was obtained from vermicompost 20000 kg ha^{-1} with 124.53 g, and from vermicompost + chemical fertilizer application with 122.78 g. The highest oil ratio value was obtained from cattle manure 20000 kg ha^{-1} with 27.14%. The highest protein content value was obtained from cattle manure + chemical fertilizer applications with 11.68%. In Kahramanmaraş conditions, in order to obtain the highest seed yield in sunflower cultivation for confectionery, the following applications can be recommended, respectively: 3600.04 kg ha^{-1} from the vermicompost + chemical fertilizer, 3518.47 kg ha^{-1} from the cattle manure + chemical fertilizer, and 3484.85 kg ha^{-1} from the vermicompost 20000 kg ha^{-1}. According to the research results, it was determined that organomineral fertilizers can be used at lower costs in addition to organic fertilizers, and high yields can be obtained.
Keywords: *cattle manure, different fertilizer forms, gyttja, Inegöl alasi (confectionery sunflower), vermicompost, yield and yield components*

Introduction

Sunflower (*Helianthus annuus* L.) is an annual plant in the order Asterales (Campanulatae) and the family Asteraceae, belonging to the genus *Helianthus* (Khalil et al., 2015). Sunflower seeds are rich in vitamins (A and B_2), protein, oil, carbohydrates, and minerals. Shelled sunflower seeds contains 22-50% (average 36%) crude oil, 14-20% (average 17%) crude protein, 10-20% (average 15%) carbohydrates, 15-25% (average 20%) cellulose, 5-11% (average 8%) water, and 3-5% (average 4%) ash (Atakişi, 1999). In terms of plant characteristics, confectionery sunflower; seed length ranging between 10.0-20.5 mm, seed width ranging between 3.0-13.0 mm (Hofland and Kadrmas (1989); Fick and Miller (1997)), and thousand-seed weight ranging between 112.85-127.45 g (Coşkun, 2020).

Sustainable agriculture must be expanded to increase sunflower cultivation in Türkiye and reduce the import ratio.

Fertilizers that increase soil fertility have become widespread in their use as organomineral fertilizers, in addition to being of chemical and organic origin.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2306_1077510801

Chemical fertilizer is produced to increase the amount of inorganic substances in the soil that must be present in a form available for plant uptake. It is termed chemical fertilizer because artificial applications are used in the production phase. The use of chemical fertilizers in inappropriate doses causes environmental problems and waste of resources, impacting sustainable agriculture. Producers should be informed about chemical fertilizer use and alternative fertilizer options, chemical fertilizer use should be reduced, and studies on the use of organic and chemical origin organomineral fertilizers should be increased. This study, which was conducted based on this fact, was included in order to provide a comparison opportunity with organic and organomineral fertilizers.

Organic fertilizers are materials obtained from agricultural wastes and organic origin substances that are formed as a result of agricultural activities without being subjected to any changes, as they provide both soil fertility and nutrients to plants. In addition, since organic fertilizers protect the main structure of the soil and promote sustainable agriculture, they are not only used for the purpose of increasing yield and nutrients in agricultural production. One of the ways to increase productivity in crop production is to preserve the organic matter content of the soil and further enhance organic matter further. Therefore, in agricultural production, it is necessary to apply organic fertilizers, which serve as a source of organic matter and are rich in plant nutrients (Anonymous, 2025a).

Regarding the fertilizers used in the study, vermicompost is obtained through the process of composting organic waste by worms. Vermicompost, also referred to as vermicast or cast, is produced through this process. The concept of vermiculture has emerged with the use of materials of organic origin in agricultural production. Vermicompost supports sustainable agriculture (Ersoy et al., 2017).

Gyttja is a light-colored gray, brown and blackish fertilizer formed by the mixture of both mineral and organic substances (Saltalı, 2015). Gyttja, which is obtained as a by-product in the Afşin-Elbistan district of Kahramanmaraş province, is used as an organic material in agricultural areas, increasing the presence of soil organic substances and supporting the improvement of soil properties. Gyttja holds an important position in terms of ensuring crop productivity and sustainability in agriculture. It has been reported that the gyttja reserve that can be used as an organic origin material in the plant production areas of the A and B thermal power plants located in the Afşin-Elbistan coal basin, is approximately 1.8 billion tons, and it has reaching 4.8 billion tons with the regions to be opened to production in this coal basin (Kadıoğlu et al., 2015). It is a necessity in today's economic conditions to increase the usage areas of gyttja material, which has high reserves and is economically low cost, and to inform and popularize the use of gyttja material to producers. In a study conducted on this subject, researchers stated that gyttja (provided from Afşin-Elbistan lignite coal basin) improves the water holding capacity, hydraulic conductivity, aeration capacity and aggregate stability in the soil (Akyıldız, 1979). In another field study, it was reported that gyttja improves the physical and chemical structure of the soil and that these improvements would become more pronounced over time (Torun, 2009). Another organic fertilizer used in the study is cattle manure. Cattle manure is an organic fertilizer prepared by scientific and technical methods from cow manure that has been fermented approximately two months through a fermentation process (Anonymous, 2022a).

Regarding organomineral fertilizers, we can define them as fertilizers obtained by combining organic content or one or more organic fertilizers with a mixture of primary, secondary, and micronutrient elements. One of the greatest benefits of using organomineral fertilizers is that the organic matter they contain facilitates the conversion

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
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of chemical fertilizers into forms that are readily available for plant uptake (Aşık and Katkat, 2017). Since organic and organomineral fertilizers enhance yield and quality, it has been reported in other studies that there is a need to increase their effectiveness and conduct detailed research on their reactions in the soil (Erdal, 2018). Organomineral fertilizers may include organic material sources such as farmyard manure, compost, wastewater treatment sludge, leonardite, gyttja, humic acid, and biogas (Kacar and Katkat, 1999; Olaniyi et al., 2010; Süzer, 2010a, b; Makinde et al., 2011; Süzer and Çulhacı, 2016). In confectionery sunflower cultivation, organomineral fertilizers are applied as a mixture of plant nutrient elements such as phosphorus (P), nitrogen (N), zinc (Zn), and sulfur (S) with organic materials (e.g., humic-fulvic acids, compost), contributing to the preservation and enhancement of soil and crop productivity. Materials of organic origin enhance the soil's mineral retention capacity, enhance the presence of trace elements, balance pH levels, and generally have positive effects. Organomineral fertilizers help store water supplied to the soil through rainfall or irrigation systems, reduce erosion, and minimize the loss of plant nutrients. In recent years, as an alternative to chemical fertilizers, the production and use of organomineral fertilizers, farmyard manure, leonardite, and vermicompost (worm manure) have been studied, and efforts to promote these practices should be supported (Anonymous, 2025a).

In today's conditions, both in the world an in Türkiye context, when evaluating the progress in research on fertilization in agriculture, it is evident that organic-based fertilizers should be increasingly prioritized in confectionery sunflower cultivation. It can be stated that such studies are insufficient, particularly in Türkiye. Conducting these studies within the framework of sustainable agriculture is a necessity.

When examining sunflower data, as of 2020, 2.6% of the total global sunflower production (50229567 tons, increasing to 58574867 tons in 2023) and 12.0% of Türkiye's sunflower production were for confectionery purposes (Anonymous, 2025b). In the 2022-23 sunflower production period, Türkiye's sunflower supply was 8,359,620 tons [available production (2529600 tons) + imports (5830020 tons) - production loss (20,400 tons)], with domestic consumption at 4935036 tons and exports at 3402238 tons. Per capita sunflower consumption was recorded at 56.5 kilograms, with a self-sufficiency rate of 51.3% (TURKSTAT, 2025a). In Türkiye, among the annual and snack crops grown, groundnuts, pumpkin seeds, popcorn and confectionery sunflower are consumed with pleasure. According to TURKSTAT data for 2024, the production of these crops is 246796 tons of groundnuts (in shell), 7891 tons of snack pumpkin seeds, 340000 tons of confectionery sunflower and 1855000 tons of oilseed sunflower (TURKSTAT, 2025b). In a study, the average planted area for popcorn was reported as 9500 ha (Öztürk et al., 2019). According to 2024 TURKSTAT statistical data, with an average corn yield of 10260 kg ha^{-1}, popcorn production (assuming a planted area of 10000 ha) is approximately 102600 tons. The total sunflower planted area was 973722 ha (confectionery sunflower: 118799 ha; oilseed sunflower: 854924 ha), with an average yield of 2254 kg ha^{-1} (confectionery sunflower: 2870 kg ha^{-1}; oilseed sunflower: 2180 kg ha^{-1}), resulting in a total production of approximately 2195000 tons (confectionery sunflower: 340000 tons; oilseed sunflower: 1855000 tons). The top ten provinces in Türkiye for confectionery sunflower production are Konya (76297 tons), Kayseri (60000 tons), Aksaray (56035 tons), Erzurum (22215 tons), Sivas (21964 tons), Denizli (16725 tons), Kahramanmaraş (11841 tons), Bursa (9503 tons), Muş (8023 tons), and Erzincan (7870 tons). The highest confectionery sunflower yield was recorded in Tokat (3670 kg ha^{-1}), followed by Kayseri (3570 kg ha^{-1}) (TURKSTAT, 2025b). As can be understood from the data, Kahramanmaraş province

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
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meets 3.48% of Türkiye's production in confectionery sunflower production (11841 tons), while providing a yield of 2910 kg ha^{-1}, slightly above the average yield in Türkiye (2870 kg ha^{-1}). In line with this information, sustainable confectionery sunflower farming practice in Kahramanmaraş province is a must.

As can be seen from above data, Türkiye is dependent on foreign countries to meet its sunflower needs, and billions of dollars are paid to these foreign countries for these and similar agricultural products that have to be imported. In order to reduce Türkiye's inadequacy in this area, that is, its external dependency, it will increase the yield in sunflowers, which will ultimately lead to the expansion of production areas with its income to farmers. Furthermore, the study is is significant for the country's agriculture and economy.

For this purpose, it is crucial to identify the appropriate fertilizer form, which is one of the key factors that will increase the productivity of sunflower seed cultivation under Kahramanmaraş ecological conditions. This study will guide the R&D studies to be carried out later and contribute to the awareness of the producer. Although studies have been conducted on fertilizer applications within the scope of sustainable agriculture, they are not sufficient. For this reason, this study is considered to be quite original. Therefore, the study includes different organic fertilizers (vermicompost, gyttja, cattle manure), chemical fertilizers (N and P_2O_5) and organomineral fertilizers (gyttja + chemical fertilizer, vermicompost + chemical fertilizer, cattle manure + chemical fertilizer) applications in sunflower seed cultivation.

The research was carried out in 2021-22 to determine the effects of chemical, organic and organomineral fertilizer applications on yield and some quality parameters in sustainable confectionery sunflower (*Helianthus annuus* L.) cultivation in Kahramanmaraş/Türkiye conditions. The study is based on the hypothesis that by demonstrating the advantages of chemical, organic and organomineral fertilizers, they will provide yield and quality values equal to or higher than those obtained from chemical fertilizer applications alone and will provide a more sustainable production.

Materials and methods

Materials

Trial year and location

This study was conducted to determine the effects of organic, organomineral and chemical fertilizer applications on yield and some quality parameters in sustainable confectionery sunflower (*Helianthus annuus* L.) cultivation. In the study, "İnegöl Alası" was used as the plant material. Data on yield and some quality parameters of confectionery sunflower were obtained from the experimental field of Kahramanmaraş Sütçü İmam University, Faculty of Agriculture, Department of Field Crops in 2021-22 according to the randomized complete block design with 3 replications.

Soil characteristics of the trial area

It was determined by the Soil Analysis Laboratory of Kahramanmaraş Sütçü İmam University ÜSKİM (University Industry Public Cooperation Development Application and Research Center) that the soil of the trial area was slightly alkaline with a pH of 7.58, low in organic matter with 1.16%, had a lime ratio of 0.93%, was rich in phosphorus (4.73 ppm), and had a clay-loam structure.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
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Climatic characteristics of the trial area

Kahramanmaraş is geographically located in the Eastern Mediterranean Region of Türkiye between 27° 11’-38° 36’ north latitude and 36° 15’-37° 41’ east longitude. It is influenced by a Mediterranean climate in regions up to 800 m in altitude and exhibits climate characteristics at higher elevations. According to the 2023 Reports of the Provincial Directorate of Meteorology, when the average temperature and total precipitation values for the years 2021-22 when the experiment was carried out, when the temperature values between January and December of 2021-2022 were compared with the long-term (1930-2021) average, it was observed that in April (16.60-17.50°C) of 2021-22, the temperature was above the long-term average (1.50-2.4°C), while in May (23.50-19.70°C), June (25.50-25.90°C), and July (30.30-29.20°C) following planting and in August (30.00-29.40°C) when the harvest was conducted, the temperature was above the long-term average (“3.40 and -0.4”, “0.60 and 1.0”, “2.00 and 0.9”, and “1.60 and 1.0”°C, respectively), except for May 2022. were realized (*Table 1*).

Table 1. *Climate values (monthly average temperature, total precipitation) of Kahramanmaraş between April-August 2021-22 and long-term (1930-2021)*

	Average temperature (°C)					**Monthly total precipitation (mm)**				
Months	**2021**	**2022**	**LTA (1930-2021)**	**DIF (2021-UYO)**	**DIF (2022-UYO)**	**2021**	**2022**	**LTA (1930-2021)**	**DIF (2021-UYO)**	**DIF (2022-UYO)**
January	7.0	4.1	4.8	2.2	-0.7	204.3	139.2	124.0	80.3	15.2
February	9.3	8.2	6.2	3.1	2.0	29.5	70.6	112.2	-82.7	-41.6
Mart	10.4	6.9	10.4	0.0	-3.5	137.1	99.8	95.1	42.0	4.7
April	16.6	17.5	15.1	1.5	2.4	16.2	9.8	73.0	-56.8	-63.2
May	23.5	19.7	20.1	3.4	-0.4	8.2	28.8	38.8	-30.6	-10.0
June	25.5	25.9	24.9	0.6	1.0	0.0	4.0	8.6	-8.6	-4.6
July	30.3	29.2	28.3	2.0	0.9	0.5	0.0	2.7	-2.2	-2.7
August	30.0	29.4	28.4	1.6	1.0	7.4	0.0	2.2	5.2	2.2
September	25.1	25.6	25.0	0.1	0.6	1.5	4.8	11.0	-9.5	-6.2
October	19.7	20.2	18.9	0.8	1.3	3.3	3.0	45.4	-42.1	-42.4
November	13.8	13.3	11.8	2.0	1.5	34.2	65.4	78.0	-43.8	-12.6
December	7.5	9.1	6.6	0.9	0.9	304.4	27.6	130.6	173.8	173.8
AV	18.23	17.43	16.71	1.52	0.58					
TO						746.60	453.00	721.60	25.00	12.60

Reference: Meteorological Report of the Provincial Directorate of Meteorology for the Years 1921, 1922, and 1930-2021
Long-term average (1930-2021): LTA, Difference: DIF, Average: AV, Total: TO

In terms of precipitation, the long-term average precipitation between April and August was 125.3 mm, whereas the total precipitation between April and August in 2021-22 was 32.3-42.60 mm. When the precipitation values of 2021-2022 were compared with the long-term average (1930-2021), the precipitation in April, May, June and July of 2021 and 2022 was below the average, the precipitation in August was above the precipitation average of 2021, and the precipitation in 2022 was below the average (*Table 1*).

Characteristics of the confectionery sunflower variety used in the research

The seeds of “İnegöl Alası” (confectionery sunflower) used were obtained from farmers who are members of the Elbistan Chamber of Agriculture. The variety was registered by the İnegöl Municipality in 2013. The plant height of the variety is 157 cm,

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2306_1077510801

flowering duration is 78 days, emergence duration is 15 days, seed coat color is gray-white, physiological maturity day number is 134, thousand-seed weight is 112.08 g, oil ratio (%) is 36.4%, oil yield (kg ha^{-1}) is 752.0-1205.0 kg, and protein content (%) is 17.18% as reported by Yılmaz et al. (2017) and Anonymous (2022b, 2025c).

Fertilizers used in the experiment and their properties

In the experiment, a control (without fertilizer) and 11 different fertilizer applications were made. These included the control, chemical fertilizer (90 kg ha^{-1} N and 50 kg ha^{-1} P_2O_5), organic fertilizers; gyttja 10000 kg ha^{-1}, gyttja 20000 kg ha^{-1}, gyttja 80000 kg ha^{-1}, vermicompost 10000 kg ha^{-1}, vermicompost 20000 kg ha^{-1}, cattle manure 10000 kg ha^{-1}, cattle manure 20000 kg ha^{-1}, organomineral fertilizers; gyttja (1000 kg ha^{-1}) + chemical fertilizer (90 kg ha^{-1} N and 50 kg ha^{-1} P_2O_5), vermicompost (1000 kg ha^{-1}) + chemical fertilizer (90 kg ha^{-1} N and 50 kg ha $^{-1}$ P_2O_5), and cattle manure (1000 kg ha^{-1}) + chemical fertilizer (90 kg ha^{-1} N and 50 kg ha^{-1} P_2O_5).

Regarding the chemical and organic fertilizer materials used in the trial; cattle manure, which is the subject of the research, was supplied by "Yeşil Hayat Makine Sanayi ve Ticaret A.Ş.". vermicompost was supplied by "İSSOL Organik Solucan Gübresi" Fertilizer Company, certified by the Ministry of Agriculture and Forestry (according to a verbal interview with company officials, the company closed in 2021). Gyttja (incompletely coalified organic material found on or between the lignite layer in the coal basin of Afşin-Elbistan Thermal Power Plant) was supplied from the Afşin-Elbistan Thermal Power Plant.

Regarding the fertilizers used in the experiment, according to the Regulation on Organic, Mineral, and Microbial Fertilizers Used in Agriculture, issued by the Ministry of Agriculture and Forestry of Türkiye on February 23, 2018 (Official Gazette No. 30341), organic fertilizers are defined as products obtained from plant- and/or animal-based wastes and/or residues that contain plant nutrients in organic compounds, improve the physical, chemical, and biological properties of the soil, and facilitate nutrient uptake by enhancing nutrient availability, and organomineral fertilizers are defined as products obtained through the combination or reaction of organic matter and/or organic fertilizers with one or more primary, secondary, or micronutrient elements (Anonymous, 2025d). Within this framework, for solid NP (nitrogen-phosphorus) organomineral fertilizers, the regulation specifies the following criteria under the heading "composition, quantity of raw materials, required nutrient content, and other standards": organic matter content must be at least 15%, and the total N + P_2O_5 content must be at least 12% (Anonymous, 2025e). Based on these provisions, the organomineral fertilizer applications used in the present study were standardized according to these specified ratios.

The types, doses, and contents of the fertilizers used are presented in *Tables 2* and *3*.

As of 2021, free-market fertilizer prices were as follows; vermicompost at 3000 TL per ton, gyttja at 270 TL per ton, cattle manure at 1500 TL per ton, 20.20.0 compound fertilizer at 300 TL per 50 kg, and Ammonium Sulphate at 300 TL per 50 kg.

Examination of the data indicates that, with all other practices held constant, organomineral fertilizers are generally less costly than organic fertilizers (*Table 2*).

All organic fertilizers used in the experiment were applied in solid form. Farmyard manure was in granular form, while vermicompost and gyttja were also applied in solid state. Organic fertilizers were broadcast on the field before sowing and incorporated into the soil to a depth of approximately 0–15 cm using a rake. Application rates were calculated on a dry-matter basis to ensure consistency among treatments. Chemical fertilizers were applied at a rate of 90 kg ha^{-1} N and 50 kg ha^{-1} P_2O_5, with 50 kg ha^{-1} N

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2306_1077510801

and 50 kg ha^{-1} P_2O_5 applied as a basal dose, and the remaining 4 kg da^{-1} N applied as a top-dressing when plants reached 30 cm in height. As stated by Saltalı (2015), gyttja is a light-colored material (gray, brown, or blackish) formed by the mixture of mineral and organic substances. It is relatively stable, rich in organic matter, and has colloidal properties. These characteristics improve soil physical structure and water-holding capacity. From an agronomic perspective, gyttja enhances the availability of nutrients for plant uptake, improves soil aeration and root development, and thereby positively influences plant growth.

Table 2. *Types and doses of chemical, organic and organomineral fertilizers used*

	Fertilizer types and doses		Dose (kg ha^{-1})	Cost (TL)
1	Control plot	Control	Without fertilizer	0
2	Chemical fertilizer	CF	90 N + 50 P_2O_5 (50 kg N 50 kg P_2O_5 as base fertilizer together with sowing, the remaining part of N (4 kg) as top fertilizer when the plant is 30 cm)	264.30
3	Gyttja-I	G1	10000	270.00
4	Gyttja-II	G2	20000	540.00
5	Gyttja-III	G3	80000	2160.00
6	Vermicompost-I	V1	10000	3000.00
7	Vermicompost-II	V2	20000	6000.00
8	Cattle manure-I	CM1	10000	1500.00
9	Cattle manure-II	CM2	20000	3000.00
10	Gyttja + chemical fertilizer	GCF	Gyttja (1000) + chemical fertilizer (90 kg N + 50 kg P_2O_5)	291.30
11	Vermicompost + chemical fertilizer	VCF	Vermicompost (1000) + chemical fertilizer (90 kg N + 50 kg P_2O_5)	564.30
12	Cattle manure + chemical fertilizer	CMCF	Cattle manure (1000) + chemical fertilizer (90 kg N + 50 kg P_2O_5)	414.3

Methods

In the study, data on yield and some quality parameters of sunflower plants were obtained from the trial area of Kahramanmaraş Sütçü İmam University, Faculty of Agriculture, Department of Field Crops, and the studies carried out before and after sowing are described below.

Experimental design

The investigated characteristics were as follows; the plots were established with 3 replications according to the randomized complete block design, measuring 14 m^2 (0.70 m inter-row spacing × 4 rows × 5.00 m = 14 m^2), 12 plots in each block, 140 cm between plots and 3 m between blocks. In the experiment, the middle two rows of each plot were harvested, resulting in a total net harvested area of 252 m^2, and a total experimental area of 1029 m^2.

$$\text{Net harvested area} = 0.70 \text{ m inter-row spacing} \times 2 \text{ rows} \times 5.00 \text{ m plot length} \times 36 \text{ plots} = 252 \text{ m}^2$$

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$$\text{Total experimental area} = [(0.70 \text{ m inter-row spacing} \times 4 \text{ rows} \times 12 \text{ plots}) + (11 \times 1.40 \text{ m plot spacing})] \times [(5.00 \text{ m plot length} \times 3 \text{ blocks}) + (3.00 \text{ m} \times 2 \text{ blocks spacing})] = 49.00 \text{ m} \times 21.00 \text{ m} = 1029 \text{ m}^2$$

Table 3. *Types and contents of chemical, organic and organomineral fertilizers used in the experiment*

Fertilizer type	Content	Amount
Vermicompost[1]	Organic matter (%)	35.00
	Total nitrogen (%)	1.30
	Organic nitrogen (%)	1.00
	Total humic fulvic acid (%)	20.00
	Maximum electrical conductivity (EC) (dS/m)	3.00
	C/N (%)	12.94
	Minimum moisture (%)	35.00
	pH	6.00-8.00
Cattle manure[2]	Organic matter (%)	60.00
	Total nitrogen (%)	2.80
	Total phosphorus penta oxide (P_2O_5) (%)	2.40
	Water soluble potassium oxide (K_2O) (%)	2.50
	Total humic + fulvic acid (%)	31.00
	C/N %	12.03
	Maximum humic (%)	20.00
	Maximum EC (dS/m)	4.00
	pH	6.50-8.50
	Form (%)	Granule
Gyttja[3]	Organic matter (%)	43.00
	Total nitrogen (%)	1.13
	Lime (%)	34.00
	Potassium (mg/kg)	140.00
	Calcium (mg/kg)	10280.00
	Iron (mg/kg)	11.00
	Manganese (mg/kg)	2.20
	Humic acid (%)	34.00
	Maximum EC (dS/m)	2.14
	pH ratio	7.10
Chemical fertilizer[4]	**20.20.0 Compound fertilizer**	
	Total nitrogen (N) (%)	20.00
	Ammonia nitrogen (N-NH_4) (%)	8.00
	Urea nitrogen (N-NH_2) (%)	12.00
	Water soluble phosphorus pentoxide (P_2O_5) (%)	17.00
	Neutral ammonium citrate and water-soluble phosphorus pentoxide (P_2O_5) (%)	20.00
	Ammonium sulfate	
	Total nitrogen (N) (%)	20.5
	Total sulfur (S) (%)	24

[1]Issol Vermicompost Fertilizer (Anonymous, 2022c)
[2]Yeşil Hayat Fertilizer (Anonymous, 2022a)
[3]Afşin-Elbistan Thermal Power Plant (Yıldırım, 2015)
[4]İGSAŞ Chemical Fertilizer (Anonymous, 2022d)

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2306_1077510801

While the plots were placed in a certain order in the first block (control, CF, G1, G2, G3, V1, V2, CM1, CM2, GCF, VCF, CMCF), within other blocks, all treatments (chemical, organic, and organomineral fertilizers) were randomly assigned to plots, ensuring that each treatment appeared once per block. Soil heterogeneity was considered as the blocking factor. To minimize field variability, randomization applied in the first year was also performed independently in the second year.

Cultural practices applied in experiment

Sowing and maintenance operations

Soil preparation began in the autumn with an initial deep plowing, and the soil overwintered in this condition.

Before sowing, deep plowing was performed with a plow at the beginning of March, and just before sowing, shallow tillage was conducted with a cultivator, then a land roller was used, and the soil was prepared for sowing. No treatment was applied to the control plot after the parceling process. The types and doses of fertilizers used were as follows: chemical fertilizer (90 kg ha^{-1} N and 50 kg ha^{-1} P_2O_5), organic fertilizers; gyttja 10000 kg ha^{-1}, gyttja 20000 kg ha^{-1}, gyttja 80000 kg ha^{-1}, vermicompost 10000 kg ha^{-1}, vermicompost 20000 kg ha^{-1}, cattle manure 10000 kg ha^{-1}, cattle manure 20000 kg ha^{-1}, organomineral fertilizers; gyttja (1000 kg ha^{-1}) + chemical fertilizer (90 kg ha^{-1} N and 50 kg ha^{-1} P_2O_5), vermicompost (1000 kg ha^{-1}) + chemical fertilizer (90 kg ha^{-1} N and 50 kg ha $^{-1}$ P_2O_5), cattle manure (1000 kg ha^{-1}) + chemical fertilizer (90 kg ha^{-1} N and 50 kg ha^{-1} P_2O_5). The chemical fertilizer application method involved applying 20.20.0 compound fertilizer, providing 5 kg N and 5 kg P_2O_5 as basal fertilizer at sowing, and the remaining nitrogen (4 kg) from ammonium sulfate (approximately 21% N) was incorporated into the soil as top fertilizer using a rake when the plants reached 30 cm. Organic fertilizer applications, including gyttja, vermicompost, and cattle manure doses, were applied to the soil approximately one week before sowing and incorporated using a rake. For organomineral fertilizer applications, *the organic component* of the organomineral fertilizers was applied to the soil approximately one week before sowing and incorporated with a rake, while the *chemical fertilizer components* were applied as described above: 5 kg N and 5 kg P_2O_5 at sowing, and 4 kg N as top fertilizer when the plants reached 30 cm, incorporated into the soil using a rake.

The first year's sowing was conducted on April 9, 2021, and the second year's sowing was conducted on April 7, 2022, using the pit method, with 3 seeds sown in 4 rows, maintaining 70 cm row spacing and 30 cm intra-row spacing, in furrows opened with hand markers to ensure seed emergence.

After sowing, emergence irrigation was performed immediately following sowing in both years. It was observed that emergence was healthy after sowing in the trial area. The drip irrigation method was applied for subsequent irrigation operations and irrigation was performed 7 times in 2021 and 14 times in 2022. As seen in *Table 1,* the total rainfall of the growing period is quite high in 2021 (746.6 mm) compared to 2022 (453.0 mm). This shows that plants developed in drier climate conditions in 2022. The difference in the number of irrigations between years resulted from adjustments in irrigation frequency to meet the water requirements of the plants. Irrigation was applied sufficiently to satisfy plant needs, but the exact amounts (in millimeters) were not measured.

In both years, thinning was performed when the plants reached 20 cm. In 2021, the first hoeing was performed on May 10, 2021, the 2nd hoeing was carried out on June 3, 2021, and the 3rd hoeing was carried out on June 27, 2021, and in 2022, a total of 3 hoeing

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2306_1077510801

operations were carried out: the first hoeing was carried out on May 05, 2022, the 2nd hoeing was carried out on June 6, 2022, and the 3rd hoeing was carried out on June 30, 2021. When the plants were 30 cm, 4 kg of nitrogen was applied to the soil as top fertilizer.

Harvest

Maturity dates were determined before harvesting. Harvest time; as a result of the yellowing of the back of the flower beds and browning of the stems, it was harvested by hand on August 16, 2021 and August 12, 2022. Following harvesting, threshing was performed by hand.

Various photographs related to the experiment

Some photographs related to the experiment are presented in *Figure 1*.

Figure 1. *Some photographs from the sunflower trial area (plot layout, pre-sowing shots after soil preparation, drip irrigation during seedling growth, flowering period)*

Analyzed characteristics and methods employed

Among the yield and quality parameters, the following were determined: the number of seeds per head (pieces), the number of filled seeds per head (pieces), the number of

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2306_1077510801

unfilled seeds per head (pieces), the seed filling percentage (%), seed yield (kg ha^{-1}), thousand-seed weight (g), hectoliter weight (g L^{-1}), dehulled ratio (%), hull ratio (%), protein content (%), oil ratio (%) were determined according to the method specified by Çetin (2003), Anonymous (2025f), Davulcu (2016), Pekcan (2014) and Altuner (2002).

In the observations, the confectionery sunflower was planted in 4 rows using a 70 cm intra-row spacing and 30 cm inter-row spacing, plant characteristics were examined on 10 plants, and grain yield was observed on 20 plants. Therefore, plot yield was calculated as 4.2 m².

$$\text{Plot yield} = 20 \text{ plants} \times 0.30 \text{ m in-row spacing} \times 0.70 \text{ m between rows} = 4.2 \text{ m}^2$$

This value was then proportional to 10,000 m² (1 ha), and grain yield was calculated in kilograms per hectare.

From the measurements related to the examined features:

Seed number per head (no.) was determined by threshing 10 heads per plot and counting the total seeds (Altuner, 2002). Filled and unfilled seed numbers (no.) were identified from the same sample by separating filled and empty seeds after threshing.

The average seed filling percentage (%) was calculated by separating filled and empty seeds, weighing them, and expressing the proportion of filled seed weight relative to the total seed weight (filled + empty) (Tursun, 2011).

Plot yield (kg da^{-1}) was determined as grain yield without moisture correction. Yields were adjusted to 10% seed moisture content according to the standards of the Seed Registration and Certification Center, and expressed as grain yield per hectare (Anonymous, 2025f).

Thousand-seed weight (g) was calculated by weighing four subsamples of 100 seeds per replication, averaging, and multiplying by 10 (Anonymous, 2025f).

Test weight (g L^{-1}) was measured as the weight of a unit volume of seeds (Anonymous, 2025f).

Kernel ratio (%) was determined by separating kernels and hulls from 4 × 100 seeds per plot, drying at 105°C for 3 h, and calculating the kernel-to-hull weight ratio (Çetin, 2003).

Hull ratio (%) was calculated similarly, by drying hull fractions of 4 × 100 seeds per plot at 105°C for 3 h, and expressing hull weight as a percentage (Anonymous, 2025f).

Crude protein content (%) was determined based on the seed protein ratio (Pekcan, 2014).

Oil ratiot (%) was measured by the Nuclear Magnetic Resonance (NMR) system at ÜSKİM Laboratory at 0% moisture level (Anonymous, 2025f).

Statistical evaluation of results

The data obtained through observation, measurement, weighing and counting of the determined characters were analyzed using the SAS 9.0 software package for variance analysis of variance according to a randomized complete block design. Significant differences were subjected to the LSD multiple comparison test (at significance levels of $P \leq 0.05$ or $P \leq 0.01$).

Results and discussion

Since sunflower has a wide adaptation ability, it can grow easily in different climate zones. Therefore, it also shows a wide range of change in terms of seed yield and quality parameters.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2306_1077510801

According to the findings; the effects of chemical, organic and organomineral fertilizer applications on the number of seeds per head, the number of filled seeds per head, the number of unfilled seeds per head, the seed filling percentage, seed yield, thousand-seed weight, the protein content were found to be very important, and the effect on the oil ratio was found to be significant.

The effects of year and the year × fertilizer treatment interaction were evaluated by considering the climatic variations and their reflections on yield components. As shown in *Table 1,* the total precipitation during the growing season was considerably higher in 2021 (746.6 mm) compared to 2022 (453.0 mm), indicating that plants in 2022 grew under relatively drier conditions. These climatic differences were clearly reflected in plant performance. Except for hull ratio, protein content, and oil percentage, all other examined traits showed statistically higher values in 2022 than in 2021. The relatively lower rainfall and slightly warmer conditions in 2022 likely shortened the vegetative period and enabled more efficient translocation of assimilates toward the reproductive organs, thereby contributing to better seed filling and maturation processes. The significant year × fertilizer treatment interaction indicates that the efficiency of fertilizer applications varied between years. In 2022, under drier conditions, certain fertilizer forms or doses appeared to perform more effectively, whereas in 2021, higher rainfall might have led to nutrient leaching or reduced nutrient availability, thereby limiting yield responses. In summary, the differences observed between years and their interaction with treatments were primarily driven by variations in rainfall and temperature patterns. These climatic fluctuations had a decisive biological influence on nutrient uptake, seed development, and final yield performance of the plants.

The mean values for the number of seeds per head, number of filled seeds per head, number of unfilled seeds per head, seed filling percentage, seed yield and thousand-seed weight, hectoliter weight, dehulled ratio, hull ratio, protein content, oil ratio of different fertilizer applications in confectionery sunflower and the resulting LSD groups are given in *Tables 4* and *5*.

Number of seeds per head (pieces)

As seen in *Table 4,* the difference between years, fertilizer forms and year × fertilizer forms interactions in terms of number of seeds per head was found to be significant at 1% level. The number of seeds per head of the years was obtained with 871.87 pieces in the Y2 year, which was higher than the Y1 year with 561.79 pieces. The lowest number of seeds per head for fertilizer forms was obtained from G1 application with 571.79 pieces, while the highest number of seeds per head was obtained from VCF application with 818.17 pieces. The average values of number of seeds per head for year × fertilizer forms interactions varied between 426.59-1017.57 pieces. The lowest number of seeds per head was obtained from Y1 × G1 application with 426.59 pieces, while the highest number of seeds per head was obtained from Y2 × V2 with 1017.57 pieces and Y2 × VCF applications with 1001.87 pieces.

The finding of 724.68 pieces in the CF application is compatible with the result of the study conducted by Coşkun (2020) with the same variety and similar N dose (8 kg da^{-1}) application (756.40 units). However, it differs from the result of the study conducted by Sarı (2021) with the same variety, similar sowing time (second week of April) and chemical fertilizer application but in a different sowing year (817.80 pieces). It is thought that this difference in the number of seeds in the tray is due to the fact that they were grown in years with different climatic conditions.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2306_1077510801

Table 4. *The mean values of the number of seeds per head, number of filled seeds per head, number of unfilled seeds per head, seed filling percentage, seed yield and thousand-seed weight of different fertilizer applications in confectionery sunflower and the resulting LSD groups*

		NSH	NFSH	NUFSH	SFC	SY	TSW
Years	Y1	561.79 ± 14 b	383.70 ± 13 b	178.09 ± 4 b	67.83 ± 0.8 b	2557.19 ± 88 b	103.10 ± 1.8 b
	Y2	871.87 ± 18 a	600.79 ± 14 a	271.08 ± 9 a	68.89 ± 0.8 a	3227.26 ± 111 a	124.73 ± 2.0 a
Fertilizer applications	Control	649.85 ± 72 e	394.13 ± 44 g	255.72 ± 28 a	60.64 ± 0.7 e	1803.12 ± 96 g	102.45 ± 5.3 d
	CF	724.68 ± 96 b-d	475.97 ± 65 d-f	248.70 ± 31 ab	65.50 ± 0.7 de	2593.76 ± 143 e	118.24 ± 8.8 a-c
	G1	571.79 ± 66 f	382.88 ± 54 g	188.92 ± 13 f	65.88 ± 2.1 de	2205.55 ± 241 f	110.48 ± 4.9 cd
	G2	688.55 ± 88 c-e	482.54 ± 74 c-f	206.02 ± 16 d-f	68.87 ± 2.1 bc	2692.79 ± 384 de	110.71 ± 7.0 cd
	G3	757.22 ± 56 ab	518.42 ± 26 b-e	238.80 ± 32 a-c	69.14 ± 2.0 bc	3002.57 ± 133 bc	108.34 ± 4.2 cd
	V1	668.91 ± 26 de	474.51 ± 18 ef	194.40 ± 11 ef	71.00 ± 1.0 ab	2824.55 ± 72 cd	109.04 ± 6.4 cd
	V2	779.83 ± 107 ab	522.73 ± 70 b-d	257.10 ± 38 a	67.22 ± 0.7 cd	3484.85 ± 120 a	124.53 ± 3.0 a
	CM1	758.69 ± 48 ab	542.64 ± 47 b	216.05 ± 8 c-e	71.04 ± 1.9 ab	3090.94 ± 285 b	111.84 ± 3.4 b-d
	CM2	716.92 ± 95 b-d	458.19 ± 62 f	258.73 ± 35 a	63.90 ± 1.2 e	2833.62 ± 178 cd	110.74 ± 7.5 cd
	GCF	728.52 ± 52 b-d	528.37 ± 39 bc	200.16 ± 13 ef	72.47 ± 0.4 a	3056.42 ± 154 b	121.85 ± 7.1 ab
	VCF	818.17 ± 85 a	592.79 ± 56 a	225.38 ± 29 b-d	72.82 ± 0.8 a	3600.04 ± 222 a	122.78 ± 7.1 a
	CMCF	738.80 ± 83 bc	533.73 ± 65 b	205.07 ± 20 d-f	71.86 ± 1.2 a	3518.47 ± 170 a	115.99 ± 8.7 a-c
Year × fertilizer applications (Y × FA)	Y1 × Control	497.50 ± 29 ij	301.07 ± 15 kl	196.43 ± 15 ef	60.59 ± 1.1 j	1992.38 ± 74 jk	93.74 ± 2.0 f
	Y1 × CF	514.35 ± 25 ij	333.35 ± 15 j-l	181.00 ± 13 f	64.85 ± 1.4 h-j	2311.80 ± 65 ij	99.33 ± 2.9 f
	Y1 × G1	426.59 ± 16 j	265.52 ± 20 l	161.07 ± 5 f	62.07 ± 2.4 j	1681.31 ± 26 kl	99.93 ± 2.4 f
	Y1 × G2	496.34 ± 32 ij	320.54 ± 20 kl	175.80 ± 12 f	64.6 ± 0.8 ij	1851.78 ± 16 k	96.37 ± 1.6 f
	Y1 × G3	639.60 ± 36 h	469.53 ± 25 g-i	170.07 ± 11 f	73.44 ± 0.4 a-c	2741.42 ± 59 gh	105.07 ± 7.9 f
	Y1 × V1	627.95 ± 18 h	455.52 ± 9 h-i	172.43 ± 9 f	72.57 ± 0.7 b-d	2826.60 ± 107 gh	100.24 ± 7.5 f
	Y1 × V2	542.09 ± 14 i	368.49 ± 9 jk	173.60 ± 6 f	67.99 ± 0.3 gh	3292.73 ± 86 ef	122.39 ± 5.7 bc
	Y1 × CM1	667.61 ± 25 gh	448.77 ± 20 i	218.83 ± 11 e	67.21 ± 1.3 h	2470.43 ± 48 i	106.39 ± 3.4 f

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2306_1077510801

	Y1 × CM2	513.27 ± 35 ij	328.64 ± 25 kl	184.63 ± 15 f	64.00 ± 1.9 j	2458.86 ± 100 i	94.43 ± 2.4 f
	Y1 × GCF	622.65 ± 34 h	447.44 ± 24 i	175.21 ± 10 f	71.93 ± 0.5 c-e	2739.68 ± 119 gh	108.75 ± 6.8 f
	Y1 × VCF	634.48 ± 41 h	471.91 ± 45 g-i	162.57 ± 6 f	74.40 ± 3.3 ab	3135.07 ± 279 f	111.36 ± 2.6 d-f
	Y1 × CMCF	559.03 ± 39 i	393.56 ± 30 j	165.47 ± 14 f	70.36 ± 1.6 ef	3184.23 ± 116 f	99.19 ± 6.7 f
	Y2 × Control	802.20 ± 39 e	487.20 ± 30 gh	315.00 ± 15 b	60.69 ± 1.3 j	1613.85 ± 67 l	111.15 ± 7.7 ef
	Y2 × CF	935.00 ± 37 b	618.60 ± 25 cd	316.40 ± 13 b	66.16 ± 0.5 hi	2875.72 ± 133 g	137.14 ± 4.3 a
	Y2 × G1	717.00 ± 25 f	500.23 ± 26 g	216.77 ± 1 e	69.69 ± 1.1 fg	2729.80 ± 122 h	121.03 ± 1.8 bc
	Y2 × G2	880.77 ± 29 c	644.53 ± 29 c	236.23 ± 13 de	73.14 ± 1.6 bc	3533.79 ± 176 d	125.04 ± 6.0 b
	Y2 × G3	874.83 ± 24 c	567.30 ± 18 f	307.53 ± 12 b	64.84 ± 1.0 ij	3263.71 ± 128 ef	111.62 ± 4.2 d-f
	Y2 × V1	709.87 ± 38 fg	493.50 ± 33 gh	216.37 ± 10 e	69.43 ± 1.4 fg	2822.50 ± 120 gh	117.84 ± 8.3 cd
	Y2 × V2	1017.57 ± 27 a	676.97 ± 31 b	340.60 ± 6 a	66.46 ± 1.4 hi	3676.97 ± 168 c	126.66 ± 2.9 b
	Y2 × CM1	849.77 ± 51 cd	636.50 ± 42 c	213.27 ± 14 e	74.86 ± 1.1 a	3711.44 ± 135 c	117.29 ± 4.1 c-e
	Y2 × CM2	920.57 ± 52 b	587.73 ± 39 ef	332.83 ± 23 a	63.81 ± 1.7 j	3208.38 ± 94 f	127.04 ± 3.6 b
	Y2 × GCF	834.40 ± 42 de	609.30 ± 31 de	225.10 ± 11 e	73.01 ± 0.2 bc	3373.17 ± 120 e	134.96 ± 7.0 a
	Y2 × VCF	1001.87 ± 39 a	713.67 ± 26 a	288.2 ± 13 c	71.25 ± 0.4 de	4065.02 ± 125 a	134.21 ± 8.6 a
	Y2 × CMCF	918.57 ± 29 b	673.90 ± 25 b	244.67 ± 16 d	73.37 ± 1.5 bc	3852.72 ± 141 b	132.79 ± 7.3 a
Average		716.83	492.24	224.59	68.36	2892.22	113.92
LSD (5%) for year		26.08 **	19.67 **	10.25 **	0.97 *	81.34 **	4.22 **
LSD (5%) for fertilizer applications		63.89 **	48.19 **	25.10 **	2.37 **	199.37 **	10.34 **
LSD (5%) for Y × FA		156.5 **	118.04 **	61.48 **	5.81 **	488.37 **	25.33 *
CV		7.67	8.42	9.62	2.99	5.93	7.81

CV: Coefficient of Variation, FA: Fertilizer Applications, Y: Year, Y1: 2021, Y2: 2022, CF: Chemical Fertilizer (90 kg ha^{-1} N and 50 kg ha^{-1} P_2O_5), G1: Gyttja 10000 kg ha^{-1}, G2: Gyttja 20000 kg ha^{-1}, G3: Gyttja 3000 kg da^{-1}, V1: Vermicompost 10000 kg ha^{-1}, V2: Vermicompost 20000 kg ha^{-1}, CM1: Cattle Manure 10000 kg ha^{-1}, CM2: Cattle Manure 20000 kg ha^{-1}, GCF: Gyttja-Chemical Fertilizer, VCF: Vermicompost-Chemical Fertilizer, CMCF: Cattle Manure-Chemical Fertilizer

NSH: Number of seeds per head (pieces), NFSH: Number of filled seeds per head (pieces), NUFSH: Number of unfilled seeds per head (pieces), SFC: Seed filling percentage (%), SY: Seed yield (kg ha^{-1}), TSW: Thousand-seed weight (g)

The means in the same column, expressed in lowercase and indicated with different letters, are statistically different from each other within the $P < 0.05$ error limits according to LSD test

*: 0.05, **: 0.01 significance

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2306_1077510801

The number of seeds per head (724.68 pieces) was found to be higher in CF application than in control application (649.85 pieces). The findings are similar to the results of Coşkun (2020)'s application of the same variety and similar N dose (8 kg da^{-1}) (756.40-711.27 pieces).

The number of seeds per head was found to be higher in V2 and CMCF applications than in CF application. The findings are similar to the results of the research conducted by Khodaei-Joghan et al. (2018).

Number of filled seeds per head (pieces)

The difference between years, fertilizer forms and year × fertilizer forms interactions in terms of number of filled seeds per head was found significant at 1% level. The number of filled seeds per head of the years was obtained with 600.79 pieces in the Y2 year, which was higher than the Y1 year with 383.70 pieces. The lowest number of filled seeds per head for fertilizer forms was obtained from G1 and control applications with 382.88 and 394.13, respectively, while the highest number of filled seeds per head was obtained from VCF application with 592.79 pieces. The mean values of number of filled seeds per head for year × fertilizer forms interactions varied between 265.52-713.67 pieces. While the lowest number of filled seeds per head was obtained from Y1 × G1 application, the highest number of filled seeds per head was obtained from Y2 × VCF application (*Table 4*).

The finding of 475.97 pieces in the CF application in terms of number of filled seeds per head differs from the result of the study conducted by Sarı (2021) with the same variety, similar sowing time (second week of April) and chemical fertilizer application, but in a different sowing year (609.30 pieces). It is thought that this difference in the number of filled seeds in the tray is due to the fact that it was grown in years with different climatic conditions.

Number of filled seeds per head was found to be higher in CM (cattle manure) applications compared to the control. The findings are similar to the data obtained by Gbadegesin et al. (2024) from two trials areas (1-2).

Number of unfilled seeds per head (pieces)

The difference between years, fertilizer forms and year × fertilizer forms interactions in terms of number of unfilled seeds per head was found significant at 1% level. The number of unfilled seeds per head of the years was obtained with 271.08 in the Y2 year, which was higher than the Y1 year with 178.09. The lowest number of unfilled seeds per head for fertilizer forms was obtained from G1 application with 188.92, the highest number of unfilled seeds per head was obtained from CM2 with 258.73, V2 with 257.10 and control applications with 255.72 pieces. The mean values of number of unfilled seeds per head for year × fertilizer forms interactions varied between 365.47-340.60 pieces. The lowest number of unfilled seeds per head was obtained from Y1 × G1 (161.07 pieces), Y1 × VCF (162.57 pieces), Y1 × VCF (165.47 pieces), Y1 × CMCF (170.07 pieces), Y1 × G3 (172.43 pieces), Y1 × V1 (173.60 pieces), Y1 × V2 (175.21 pieces), Y1 × GCF (175.80 pieces), Y1 × G2 (181.00 pieces), Y1 × CF (184.63 pieces) and Y1 × CM2 (184.63 pieces). The highest number of unfilled seeds per head was obtained from Y2 × V2 (340.60 pieces) and Y2 × CM2 (332.83 pieces) (*Table 4*).

The finding of 248.70 pieces in the CF application in terms of number of unfilled seeds per head differs from the result of the study conducted by Sarı (2021) with the same variety, similar sowing time (second week of April) and chemical fertilizer application,

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2306_1077510801

but in a different sowing year (208.50 pieces). It is thought that this difference in the number of unfilled seeds per head is due to the fact that it was grown in years with different climatic conditions.

Seed filling percentage (%)

As seen in *Table 4,* the difference between years in terms of seed filling percentage was found significant at the level of 5%, while the difference between fertilizer forms and year × fertilizer forms interactions was found significant at the level of 1%. The seed filling percentage of the years was obtained with 68.89% in the Y2 year, which was higher than the Y1 year with 67.83%. The lowest seed filling percentage of the fertilizer forms was obtained from control and CM2 applications with 60.64% and 63.90%, while the highest seed filling percentage of the years was obtained from VCF with 72.82%, GCF with 72.47% and CMCF with 71.86%. The mean values of the seed filling percentage of the year × fertilizer forms interactions varied between 60.69-74.86%. The lowest seed filling percentage was obtained from Y1 × Control with 60.59%, Y2 × Control with 60.69%, Y1 × G1 with 62.07%, Y2 × CM2 with 63.81% and Y1 × CM2 with 64.00%, while the highest seed filling percentage was obtained from Y2 × CM1 with 74.86%.

The finding of 65.50% in CF application in terms of seed filling percentage is compatible with the result of the study conducted by Coşkun (2020) with the same variety and similar N dose (8 kg da^{-1}) application (72.27%). However, it differs from the result of the study conducted by Sarı (2021) with the same variety, similar sowing time (second week of April) and chemical fertilizer application but in a different sowing year (74.18%). It is thought that this difference in seed filling percentage is due to the fact that it was grown in years with different climatic conditions.

Seed yield (kg ha^{-1})

As seen in *Table 4,* the difference in terms of seed yield between years, fertilizer forms and year × fertilizer forms interactions was found significant at the 1% level. The seed yield of the years was obtained with 3227.26 kg ha^{-1} in the Y2 year, which was higher than the Y1 year with 2557.19 kg ha^{-1}. While the lowest seed yield of the fertilizer forms was obtained from control application with 1803.12 kg ha^{-1}, the highest seed yield was obtained from VCF application with 3600.04 kg ha^{-1}, CMCF application with 3518.47 kg ha^{-1} and V2 application with 3484.85 kg ha^{-1}. The mean seed yield values of year × fertilizer forms interactions varied between 1613.85-4065.02 kg ha^{-1}. While the lowest seed yield was obtained from Y2 × Control application with 1613.85 kg ha^{-1}, the highest seed yield was obtained from Y2 × VCF application with 4065.02 kg ha^{-1}.

The findings regarding seed yield were found to be lower than the results of the studies conducted by Yılmaz et al. (2017) and Ergen and Sağlam (2005) with the same variety (5450.00 and 2916.50 kg ha^{-1}), and this feature is thought to be due to different sowing years, different applications and different ecological conditions.

Seed yield was found to be lower in the control application (1803.12 kg ha^{-1}) than in the chemical fertilizer application. The findings are similar to the data of similar chemical fertilizer applications by Pekcan and Esendal (2015), Yıldız (2014), Day and Kolsarıcı (2014) and Sincik et al. (2013).

Seed yield was found to be lower in the control application than in chemical and organomineral fertilizer applications. The findings are similar to the data of Öztürk (2019).

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2306_1077510801

Seed yield was found to be lower in the control application compared to chemical, organic and organomineral fertilizer applications. The findings are similar to the data of Günay (2014), Onat (2015). Similarly, Batanay (2016) found that the seed yield was higher in the organomineral fertilizer application compared to the control application in his study on safflower.

The seed yield, 2593.76 kg ha^{-1} finding in CF application, was found to be higher than the result of the study conducted by Coşkun (2020) with the same variety and similar N dose (8 kg da^{-1}) (2350.50 kg ha^{-1}). This situation in seed yield may be due to the fact that it was grown in a different year even though the same genetic material was used. Again, it differs from the result of the study conducted by Davulcu (2016) with different confectionery sunflower varieties and different locations (203.6 kg da^{-1}), it is thought that this situation in seed yield ratio is due to the fact that it was grown in different genetic material and different ecological conditions. Since sunflower has a wide adaptation ability, it can easily grow in different climatic zones. Therefore, it shows a wide range of change in terms of seed yield and other yield and quality parameters.

Seed yield was found to be higher in CF application (2593.76 kg ha^{-1}) than in control application (1803.12 kg ha^{-1}). The findings are compatible with the results of Coşkun (2020) for the same variety and similar N dose (8 kg da^{-1}) application (235.05-178.30 kg da^{-1}), and this feature is thought to be due to the genetic structure and similarity of the applications.

Seed yield was found to be higher in G (gyttja) applications than in control application (1803.12 kg ha^{-1}). The findings are similar to the results of the study conducted by Saltalı and Yıldırım (2016).

Seed yield was found to be higher in V (vermicompost fertilizer) applications than in control application. The findings are in accordance with the similar application results of Gül et al. (2021) (500 and 750 kg da^{-1} solid vermicompost fertilizer).

Seed yield was found to be higher in V (vermicompost fertilizer) applications than in CF application. The findings are similar to the results obtained by Khodaei-Joghan et al. (2018) in the application (16 t ha^{-1} vermicompost fertilizer).

Seed yield was determined to be higher in CM2 (20000 kg ha^{-1} cattle manure) application (2833.62 kg ha^{-1}) than in control application (1803.12 kg ha^{-1}). The findings are similar to the results of the study conducted by Mokgolo et al. (2019) with similar fertilizer form and dose (cattle manure 20 t ha^{-1}) application in first and second crop sunflower (1st crop 1173.20-582.47 kg ha^{-1} and 2nd crop 1646.14-968.35 kg ha^{-1}).

Seed yield was found to be higher in organomineral fertilizer applications than in CF application. The findings are similar to the data of Tamer et al. (2016) (organomineral fertilizer application (100 and 200 kg da^{-1} solid leonardite + NPK 11.8-6.3-6.3 kg da^{-1})). It is also compatible with the data of Büyükfiliz (2016) and Gholamhoseini et al. (2013).

Similarly, seed yield was found to be higher in organomineral fertilizer applications than in control and chemical and organic fertilizer applications. The findings are similar to the data of Günay (2014), Onat (2015) (12-12-12 organomineral fertilizer containing 20% organic matter, 80% mineral matter 250 kg ha^{-1}.

Seed yield was found to be higher in organomineral applications than in control application. The findings are compatible with the data of Palalı (2021).

Thousand-seed weight (g)

In terms of thousand-seed weight, the difference between years and fertilizer forms was found significant at the 1% level, while the difference between year × fertilizer forms interactions was found significant at the 5% level. The thousand-seed weight of the years

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DOI: http://dx.doi.org/10.15666/aeer/2306_1077510801

was obtained with 124.73 g in the Y2 year, which was higher than the Y1 year with 103.10 g. The lowest thousand-seed weight of the fertilizer forms was obtained with 102.45 g from the control application, while the highest thousand-seed weight was obtained with 124.53 g from the V2 and 122.78 g from the VCF applications. The thousand-seed weight mean values of year × fertilizer forms interactions varied between 93.74-137.14 g. The lowest thousand-seed weight was obtained from Y1 × Control (93.74 g), Y1 × CM2 (94.43 g), Y1 × CMCF (96.37 g), Y1 × G2 (99.19 g), Y1 × CMCF (99.33 g), Y1 × CF (99.93 g), Y1 × G1 (100.24 g), Y1 × V1 (105.07 g), Y1 × G3 (106.39 g), Y1 × CM1 (108.75 g) and Y1 × GCF (108.75 g) applications while the highest thousand-seed weight was obtained from Y2 × CF (137.14 g), Y2 × GCF (134.96 g), Y2 × VCF (134.21 g) and Y2 × CMCF (132.79 g) applications (*Table 4*).

The findings were found to be lower than the results of the study conducted by Acun (2020) with the same variety (197.1 g), and this feature is thought to be due to different applications and different ecological factors related to seed yield. Similarly, it was found to be lower than the results of the study conducted by Yılmaz et al. (2017) with the same variety (168 g) but higher than the results of Ergen and Sağlam (2005) (112.08 g), and this feature is thought to be due to different sowing years, different applications and different ecological conditions.

Thousand-seed weight was found to be lower in the control application (102.45 g) than in the chemical fertilizer application. The findings are similar to the data of similar chemical fertilizer applications of Pekcan and Esendal (2015), Yıldız (2014) and Sincik et al. (2013).

Thousand-seed weight was found to be lower in the control application compared to chemical and organomineral fertilizer applications. The findings are similar to the data of Öztürk (2019). Similarly, Batanay (2016) found that thousand-seed weight was higher in the organomineral fertilizer application compared to the control application in his study on safflower.

The finding of 118.24 g in the CF application was found to be higher than the result of the study conducted by Davulcu (2016) on different confectionery sunflower varieties and different locations (116.1 g). It is thought that this high level is due to the fact that it was grown in different genetic materials and different ecological conditions. It is thought that this situation occurring in thousand-seed weight is similarly related to the high difference in seed yield (finding 2593.76 kg ha-1, Davulcu (2016) data 203.6 kg da-1). Again, it differs from the result of the study conducted by Sarı (2021) on the same variety, similar sowing time (second week of April) and chemical fertilizer application, but in a different sowing year (126.71 g). It is thought that this difference in thousand-seed weight is due to the fact that it was grown in years with different climatic conditions.

Thousand-seed weight (118.24 g) was found to be higher in CF application than in control application (102.45 g). The findings are compatible with the results of Coşkun (2020) for the same variety and similar N dose (8 kg da^{-1}) application (135.06-105.11 g).

Thousand-seed weight was found to be higher in V2 (20000 kg ha^{-1} vermicompost fertilizer) application than in CF and CMCF applications. The findings are similar to the results obtained in Khodaei-Joghan et al. (2018) application.

Thousand-seed weight was found to be higher in VCF and GCF organomineral fertilizer applications than in CF application. The findings are similar to the data of Tamer et al. (2016) (organomineral fertilizer application (1000 and 2000 kg ha^{-1} solid leonardite + NPK 11.8-6.3-6.3 kg da^{-1})).

Thousand-seed weight was found to be higher in organomineral applications than in control application. The findings are compatible with the data of Palalı (2021).

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2306_1077510801

Hectoliter weight (g L^{-1})

The difference between the years in terms of hectoliter weight was found significant at 1% level, while the difference between fertilizer forms and year × fertilizer forms interactions was found insignificant. It is thought that the insignificance of the difference between the years, fertilizer forms and year × fertilizer forms interactions in terms of hectoliter weight is due to the use of the same genetic material in the trial even though the applications were different. The mean values of hectoliter weight of the years varied between 238.59-260.45 g L^{-1}. The hectoliter weight of the years was obtained with higher in the year Y2 than in the year Y1 (*Table 5*).

The findings were found to be higher than the results of the study conducted by Yılmaz et al. (2017) with the same variety (229 g), and this feature is thought to be due to different applications and different ecological conditions.

The finding of 260.25 g L^{-1} in the CF application in terms of hectoliter weight is compatible with the results of the study conducted by Coşkun (2020) with the same variety and similar N dose (8 kg da^{-1}) application (271.33 g L^{-1}) and the results of the study conducted by Davulcu (2016) with different confectionery sunflower varieties and different locations (286.3 g L^{-1}). This situation in hectoliter weight shows that there is no significant difference in hectoliter weights despite being grown in different genetic material and different ecological conditions.

Dehulled ratio (%)

As seen in *Table 5,* the difference between the years in terms of dehulled ratio was found significant at 1% level, while the difference between fertilizer forms and year × fertilizer forms interactions was found insignificant. It is thought that the insignificance of the difference between the years, fertilizer forms and year × fertilizer forms interactions in terms of dehulled ratio is due to the use of the same genetic material in the experiment even though the applications are different. The mean values of dehulled ratio for the years varied between 51.74-54.03%. The dehulled ratio of the years was obtained with higher than the year Y1 in the year Y2.

The findings were found to be lower than the results of the study conducted by Yılmaz et al. (2017) with the same variety (50.60%), and this feature is thought to be due to different applications and different ecological conditions.

The 51.82% finding in the CF application in terms of dehulled ratio differs from the results of the study conducted by Davulcu (2016) with different confectionery sunflower varieties and different locations (45.5%). This situation in the dehulled ratio is due to the fact that it was grown with different genetic material and different ecological conditions.

Hull ratio (%)

The difference between years in terms of hull ratio was found to be significant at 1% level, while the difference between fertilizer forms and year × fertilizer forms interactions was found to be insignificant. It is thought that the insignificance of the difference between years, fertilizer forms and year × fertilizer forms interactions in terms of hull ratio is due to the use of the same genetic material in the experiment even though the applications were different. The hull ratio average values of the years varied between 45.97-48.26%. The hull ratio of the years was obtained with higher than the year Y2, higher than the year Y1 (*Table 5*).

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2306_1077510801

Table 5. *The mean values of hectoliter weight, dehulled ratio, hull ratio, protein content, oil ratio of different fertilizer applications in confectionery sunflower and the resulting LSD groups*

		HW	HHR	HR	PC	OR
Years	Y1	238.59 ± 14 b	54.03 ± 13 a	45.97 ± 4 b	11.36 ± 0.8	30.40 ± 88
	Y2	260.45 ± 18 a	51.74 ± 14 b	48.26 ± 9 a	11.25 ± 0.8	29.22 ± 111
Fertilizer applications	Control	233.00 ± 72	52.49 ± 44	47.51 ± 28	10.84 ± 0.7 c	30.40 ± 96 ab
	CF	260.25 ± 96	51.82 ± 65	48.18 ± 31	11.22 ± 0.7 bc	30.00 ± 143 b
	G1	247.40 ± 66	54.36 ± 54	45.64 ± 13	11.44 ± 2.1 ab	29.69 ± 241 bc
	G2	247.86 ± 88	54.35 ± 74	45.65 ± 16	11.38 ± 2.1 ab	28.43 ± 384 bc
	G3	239.13 ± 56	54.24 ± 26	45.76 ± 32	11.38 ± 2.0 ab	29.87 ± 133 bc
	V1	241.58 ± 26	53.77 ± 18	46.23 ± 11	10.84 ± 1.0 c	26.81 ± 72 c
	V2	249.55 ± 107	52.99 ± 70	47.01 ± 38	11.27 ± 0.7 a-c	30.89 ± 120 ab
	CM1	240.34 ± 48	51.22 ± 47	48.78 ± 8	11.16 ± 1.9 bc	31.05 ± 285 ab
	CM2	255.13 ± 95	52.65 ± 62	47.35 ± 35	11.41 ± 1.2 ab	33.19 ± 178 a
	GCF	263.18 ± 52	52.36 ± 39	47.64 ± 13	11.56 ± 0.4 ab	29.96 ± 154 b
	VCF	259.05 ± 85	51.96 ± 56	48.04 ± 29	11.47 ± 0.8 ab	28.30 ± 222 bc
	CMCF	257.78 ± 83	52.43 ± 65	47.57 ± 20	11.68 ± 1.2 a	29.16 ± 170 bc
Year × fertilizer applications (Y × FA)	Y1 × Control	233.91 ± 4.7	52.97 ± 1.6	47.03 ± 1.6	11.44 ± 0.26 a-e	30.91 ± 0.6
	Y1 × CF	234.13 ± 14.6	54.20 ± 2.2	45.80 ± 2.2	11.41 ± 0.32 b-e	31.34 ± 0.2
	Y1 × G1	242.10 ± 8.8	55.59 ± 0.7	44.41 ± 0.7	10.85 ± 0.08 ef	30.86 ± 1.4
	Y1 × G2	234.63 ± 14.7	55.42 ± 0.3	44.58 ± 0.3	10.82 ± 0.13 ef	26.75 ± 2.1
	Y1 × G3	245.20 ± 4.2	55.11 ± 1.4	44.89 ± 1.4	11.76 ± 0.38 a-c	30.81 ± 0.5
	Y1 × V1	237.10 ± 5.9	56.03 ± 0.8	43.97 ± 0.8	11.08 ± 0.09 de	25.82 ± 4.1
	Y1 × V2	234.61 ± 2.0	53.82 ± 1.0	46.18 ± 1.0	11.47 ± 0.02 a-d	32.43 ± 0.0
	Y1 × CM1	235.77 ± 5.7	51.15 ± 0.3	48.85 ± 0.3	11.34 ± 0.24 c-e	32.10 ± 3.3
	Y1 × CM2	245.00 ± 6.4	53.37 ± 1.4	46.63 ± 1.4	11.60 ± 0.43 a-c	33.61 ± 2.0
	Y1 × GCF	244.56 ± 6.6	53.68 ± 0.3	46.32 ± 0.3	11.70 ± 0.02 a-c	32.04 ± 1.0
	Y1 × VCF	237.86 ± 11.1	53.69 ± 0.9	46.31 ± 0.9	11.08 ± 0.50 e	28.70 ± 2.0
	Y1 × CMCF	238.27 ± 7.0	53.36 ± 0.2	46.64 ± 0.2	11.76 ± 0.75 a-c	29.46 ± 0.6
	Y2 × Control	232.10 ± 16.0	52.01 ± 2.2	47.99 ± 2.2	10.25 ± 0.09 g	29.89 ± 0.6
	Y2 × CF	286.37 ± 9.0	49.43 ± 1.8	50.57 ± 1.8	11.03 ± 0.04 e	28.66 ± 0.5
	Y2 × G1	252.71 ± 3.7	53.12 ± 0.6	46.88 ± 0.6	12.02 ± 0.05 a	28.51 ± 0.8
	Y2 × G2	261.10 ± 12.4	53.29 ± 2.0	46.71 ± 2.0	11.94 ± 0.03 ab	30.11 ± 0.5
	Y2 × G3	233.06 ± 8.7	53.38 ± 0.7	46.62 ± 0.7	11.00 ± 0.09 e	28.93 ± 0.9
	Y2 × V1	246.07 ± 17.3	51.51 ± 1.4	48.49 ± 1.4	10.60 ± 0.04 f	27.81 ± 1.4
	Y2 × V2	264.49 ± 6.0	52.15 ± 0.9	47.85 ± 0.9	11.07 ± 0.03 e	29.36 ± 0.8
	Y2 × CM1	244.91 ± 8.5	51.29 ± 1.3	48.71 ± 1.3	10.98 ± 0.04 e	29.99 ± 0.7
	Y2 × CM2	265.27 ± 7.5	51.93 ± 0.2	48.07 ± 0.2	11.22 ± 0.03 de	32.76 ± 1.8
	Y2 × GCF	281.81 ± 14.5	51.03 ± 1.6	48.97 ± 1.6	11.42 ± 0.04 b-e	27.89 ± 1.5
	Y2 × VCF	280.25 ± 18.0	50.22 ± 0.9	49.78 ± 0.9	11.86 ± 0.03 ab	27.91 ± 0.5
	Y2 × CMCF	277.29 ± 15.2	51.50 ± 2.1	48.50 ± 2.1	11.61 ± 0.03 a-c	28.87 ± 0.7
Average		249.52	52.89	47.11	11.30	29.81
LSD (5%) for year		8.70 **	1.062 **	1.06 **		
LSD (5%) for fertilizer applications					0.442 **	3.07 *
LSD (5%) for Y × FA					1.083 **	
CV		7.35	4.23	4.75	3.370	8.86

CV: Coefficient of Variation, FA: Fertilizer Applications, Y: Year, Y1: 2021, Y2: 2022, CF: Chemical Fertilizer (90 kg ha^{-1} N and 50 kg ha^{-1} P_2O_5), G1: Gyttja 10000 kg ha^{-1}, G2: Gyttja 20000 kg ha^{-1}, G3: Gyttja 3000 kg da^{-1}, V1: Vermicompost 10000 kg ha^{-1}, V2: Vermicompost 20000 kg ha^{-1}, CM1: Cattle Manure 10000 kg ha^{-1}, CM2: Cattle Manure 20000 kg ha^{-1}, GCF: Gyttja-Chemical Fertilizer, VCF: Vermicompost-Chemical Fertilizer, CMCF: Cattle Manure-Chemical Fertilizer

HW: Hectoliter weight (g L^{-1}), DHR: Dehulled ratio (%), HR: Hull ratio (%), PC: Protein content (%), OR: Oil ratio (%)

The means in the same column, expressed in lowercase and indicated with different letters, are statistically different from each other within the $P < 0.05$ error limits according to LSD test.

*: 0.05, **: 0.01 significance

The findings were found to be higher than the results of Acun (2020), Yılmaz et al. (2017) and Ergen and Sağlam (2005) (46.60, 49.40 and 51.98%), and this feature is thought to be due to different sowing years, different applications and different ecological conditions.

Protein content (%)

As seen in *Table 5,* while the difference between years in terms of protein content was found to be insignificant, the difference between fertilizer forms and year × fertilizer forms interactions was found to be significant at the 1% level. The lowest protein content of fertilizer forms was obtained from control and V1 applications with 10.84%, while the highest protein content was obtained from CMCF application with 11.68%. The average values of protein content of year × fertilizer forms interactions varied between 10.25-12.02%. The lowest protein content was obtained from Y2 × Control application, while the highest protein content was obtained from Y2 × G1 application.

The findings are similar to the results of the study conducted by Acun (2020) with the same variety (11.0%), and this feature is thought to be due to genetic structure. In addition, it was found to be lower than the results of the study conducted by Ergen and Sağlam (2005) with the same variety (17.18%), and this feature is thought to be due to different sowing years, different applications and different ecological conditions.

The protein content was found to be lower in the control application compared to the chemical fertilizer application. The findings are similar to the data of Öztürk (2019), Yıldız (2014) and Sincik et al. (2013).

The 11.22% finding in the CF application in terms of protein content is similar to the result of the study conducted by Coşkun (2020) with the same variety and similar N dose (8 kg da^{-1}) application (11.69%). However, it differs from the result of the study conducted by Davulcu (2016) with different confectionery sunflower varieties and different locations (15.2%), and this situation in the protein content is due to the fact that it was grown with different genetic material and different ecological conditions.

The finding of 11.22% in the CF application in terms of protein content is similar to the result of the study conducted by Coşkun (2020) with the same variety and similar N dose (8 kg da^{-1}) application (11.69%). However, it differs from the result of the study conducted by Davulcu (2016) with different confectionery sunflower varieties and different locations (15.2%), and this situation in the protein content is due to the fact that it is grown in different genetic material and different ecological conditions.

Protein content was found to be higher in CMCF application than in V (vermicompost fertilizer) and CF applications. It is similar to the result obtained in the application of Khodaei-Joghan et al.

Oil ratio (%)

In terms of oil ratio, the difference between years and year × fertilizer forms interactions was found to be insignificant, while the difference between fertilizer forms was found to be significant at the 5% level. The average oil ratio values of fertilizer forms varied between 26.81-33.19%. The lowest oil ratio was obtained from the V1 application, while the highest oil ratio was obtained from the CM2 application (*Table 5*).

The findings were found to be higher than the results of the study conducted by Yılmaz et al. (2017) with the same variety (23.9%), but lower than the results of Ergen and

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2306_1077510801

Sağlam (2005) (36.40%), and this feature is thought to be due to different sowing years, different applications and different ecological conditions.

Oil ratio CM2 (Cattle manure 20000 kg $ha^{-1)}$ application was found to be higher than other applications. The findings are compatible with the oil ratio increasing effect of cattle manure application (15 and 20 mg ha^{-1}) compared to control and chemical fertilizer applications in two experimental areas (1-2) of Gbadegesin et al. (2024).

Oil ratio was found to be higher in control application (%30.40) than in chemical fertilizer application. The findings are similar to the data of similar chemical fertilizer application by Pekcan and Esendal (2015) and Sincik et al. (2013).

Oil ratio was found to be higher in control application (%30.40) than in chemical and organomineral fertilizer applications. The findings are similar to the data of Öztürk (2019).

In terms of oil ratio, the finding of 30.00% in the CF application is similar to the result of the study conducted by Coşkun (2020) with the same variety and similar N dose (8 kg da^{-1}) application (32.09%) and Sarı (2021) with the same variety, similar sowing time (second week of April) and chemical fertilizer application, but in a different planting year (31.50%).

The findings differ from the results of the study conducted by Acun (2020) with the same variety (25.2%), this feature is thought to be due to different applications and different ecological factors.

Oil ratio was obtained from V2, CF and CMCF applications from high to low. The findings are similar to the results obtained in the application of Khodaei-Joghan et al. (2018).

Conclusions

In this study, conducted to determine and compare the effects of chemical, organic, and organomineral fertilizer applications on yield and certain quality parameters in sustainable confectionery sunflower (*Helianthus annuus* L.) cultivation under the conditions of Kahramanmaraş, Turkey;

It is observed that the application of Vermicompost (1000 kg ha^{-1}) + chemical fertilizer (90 kg ha^{-1} N and 50 kg ha^{-1} P_2O_5) organomineral fertilizer increases the number of seeds per head.

It is observed that the application of Vermicompost (1000 kg ha^{-1}) + chemical fertilizer (90 kg ha^{-1} N and 50 kg ha^{-1} P_2O_5) organomineral fertilizer increases the number of filled seeds per head.

It was observed that the organomineral fertilizer applications of Gidya (1000 kg ha^{-1}) + chemical fertilizer (90 kg ha^{-1} N and 50 kg ha^{-1} P_2O_5), vermicompost (1000 kg ha^{-1}) + chemical fertilizer (90 kg ha^{-1} N and 50 kg ha^{-1} P_2O_5) and cattle manure (1000 kg ha^{-1}) + chemical fertilizer (90 kg ha^{-1} N and 50 kg ha^{-1} P_2O_5) increased the seed filling percentage compared to other applications.

It is observed that cattle manure (1000 kg ha^{-1}) + chemical fertilizer (90 kg ha^{-1} N and 50 kg ha^{-1} P_2O_5) organomineral fertilizer application increases the protein content compared to other applications.

It is observed that cattle manure 20000 kg ha^{-1} fertilizer application increases the oil ratio compared to other applications. In addition, it is observed that vermicompost 10000 kg ha^{-1} fertilizer application decreases the oil ratio compared to other applications, this is thought to be due to environmental and climatic factors.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2306_1077510801

It is observed that vermicompost (1000 kg ha^{-1}) + chemical fertilizer (90 kg ha^{-1} N and 50 kg ha^{-1} P_2O_5) organomineral fertilizer application and vermicompost 20000 kg ha^{-1} fertilizer application increase thousand-seed weight compared to other applications, and again chemical, organic and organomineral fertilizer applications increase thousand-seed weight compared to control application. Similar results were obtained with seed yield, which reveals that thousand-seed weight is directly related to seed yield.

Among organomineral fertilizers; the highest seed yield value was found in the stem diameter, head diameter, number of seeds per head, number of filled seeds per head, seed filling percentage and thousand-seed weight of vermicompost (1000 kg ha^{-1}) + chemical fertilizer (90 kg ha^{-1} N and 50 kg ha^{-1} P_2O_5) application; the highest seed yield value was found in the same group as cattle manure (1000 kg ha^{-1}) + chemical fertilizer (90 kg ha^{-1} N and 50 kg ha^{-1} P_2O_5) application; the highest stem diameter and thousand-seed weight values were found in the organic fertilizer vermicompost 20000 kg ha^{-1} application. Although the yield in sunflower is determined by three important components such as head number per decare, number of seeds per head and average seed weight; the common denominator was found to be the highest stem diameter in the three fertilizer applications with the highest grain yield.

It is observed that vermicompost (1000 kg ha^{-1}) + chemical fertilizer (90 kg ha^{-1} N and 50 kg ha^{-1} P_2O_5) and cattle manure (1000 kg ha^{-1}) + chemical fertilizer (90 kg ha^{-1} N and 50 kg ha^{-1} P_2O_5) organomineral fertilizer applications and vermicompost 20000 kg ha^{-1} application increase seed yield compared to other applications. Considering that Gidya (1000 kg ha^{-1}) + chemical fertilizer (90 kg ha^{-1} N and 50 kg ha^{-1} P_2O_5) application is in the second place in seed yield, it is predicted that different organic-based organomineral fertilizer applications as a fertilizer source increase yield, and considering the high cost of using only organic fertilizer, it can be preferred by farmers in terms of cost. Again, it is seen that vermicompost fertilizer increases grain yield compared to gidya applications.

In summary, in this research carried out to determine the effects of chemical, organic and organomineral fertilizer applications on yield and some quality parameters in sustainable confectionery sunflower (*Helianthus annuus* L.) cultivation; In order to obtain the highest seed yield, vermicompost fertilizer (1000 kg ha^{-1}) + chemical fertilizer (90 kg ha^{-1} N and 50 kg ha^{-1} P_2O_5) (3600.04 kg ha-1), cattle manure (1000 kg ha^{-1}) + chemical fertilizer (90 kg ha^{-1} N and 50 kg ha^{-1} P_2O_5) (3518.47 kg ha^{-1}) organomineral fertilizer and vermicompost 20000 kg ha^{-1} (3484.85 kg ha^{-1}) organic fertilizer applications are recommended since they increase seed yield compared to chemical fertilizer application.

Acknowledgements. The data for the first year of this study were obtained with the support of the BAP Coordination Unit of Kahramanmaraş Sütçü İmam University through the project numbered “2021/6-6 YLS.”

Conflict of interests. The author declares no conflict of interests to report regarding the present study.

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