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Research Article/Araştırma Makalesi

The effect of organic fertilizers on the yield components of corn plant, protein and starch content of grain

Organik gübrelerin mısır bitkisinin verim bileşenleri ile tanenin protein ve nişasta içeriğine etkisi

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ABSTRACT

The importance of organic fertilizers for sustainable agricultural production is an undeniable fact. The aim of this study is to determine the effects of different organic fertilizers on the growth and quality properties of maize plants. Three different types of organic fertilizers; cattle manure, vermicompost and leonardite, and their doses of 2.500, 5.000, 7.500 and 10.000 kgha^{-1} were used in the experiment. In addition, conventional production and non-fertilized production were used as control applications. The experiment was carried out in a randomized complete block design with three replications. The experiments were repeated to assess the residual effects of the treatments. Fertilizers were applied in 2018 to determine the residual effects of organic fertilizer applications in the second year. In the research; plant height, ear diameter, ear grain weight, 1000 grain weight, grain yield, protein ratio, oil ratio and starch ration were examined. The aim of this study is to determine the effect of different organic fertilizers on the yield components and grain content of the corn plant. These features varied between 180.72-157.87 cm, 39.38-33.59 mm, 117.1-62.2 g, 261.2-237.1 g, 4416.8-1712.9 kg ha^{-1}, 7.8-5.9%, 2.5-2.1% and 74.7-73.8%, respectively. According to the results, the 2500 kgha^{-1} and 5000 kgha^{-1} doses of vermicompost had the highest values for the oil ratio and protein ratio, on the other hand the leonardite application of 10.000 kgha^{-1} for the starch ration had the highest value. Generally, conventional fertilizer application had the highest values for yield components.

Key Words: *Zea mays* L., Organic fertilizer, Oil ratio, Protein ratio, Starch ration

ÖZ

Organik gübrelerin sürdürülebilir tarımsal üretim için önemi yadsınamaz bir gerçektir. Bu çalışmanın amacı, farklı organik gübrelerin mısır bitkilerinin büyüme ve kalite özellikleri üzerine etkilerini belirlemektir. Çalışmada üç farklı organik gübre (sığır gübresi, vermikompost ve leonardit) ve bunların dozları (2.500, 5.000, 7.500 ve 10.000 kgha^{-1}) kullanılmıştır. Ayrıca kontrol uygulamaları olarak konvansiyonel uygulama ve gübresiz uygulama yapılmıştır. Deneme tesadüf blokları deneme desenine göre üç tekerrürlü olarak yürütülmüştür. Organik gübre uygulamalarının ikinci yıldaki etkisini belirlemek için 2018 yılında gübrelemeler tamamlanmış

olup, 2019 yılında gübreleme yapılmamıştır. Araştırmada; bitki boyu, koçan çapı, koçanda tane ağırlığı, 1000 tane ağırlığı, tane verimi, protein oranı, yağ oranı ve karbonhidrat oranı özellikleri incelenmiştir. Bu özellikler sırasıyla 180.72-157.87 cm, 39.38-33.59 mm, 117.1-62.2 gr, 261.2-237.1 gr, 4416.8-1712.9 kgha^{-1}, %7.8-5.9, %2.5-2.1 ve %74.7-73.8 arasında değişim göstermiştir. Elde edilen sonuçlara göre yağ oranı ve protein oranı açısından vermikompostun 2.500 kg ha^{-1} ve 5.000 kg ha^{-1} dozları en yüksek değerlere sahip olurken, karbonhidrat oranı için 10.000 kg ha^{-1} leonardit uygulaması en yüksek değere sahip olmuştur. Genel olarak bitkisel özellikler açısından en yüksek değerler ise konvansiyonel gübreleme uygulamasından elde edilmiştir.

Anahtar Kelimeler: *Zea mays* L., Organik gübreler, Yağ oranı, Protein oranı, Karbonhidrat oranı

Introduction

Corn plant was cultivated in 197.204.250 hectares in the world, 5.823 kgha^{-1} average yield was obtained and total production value was 1.148.487.291 tons. In Turkey. They were 638.065 ha cultivation area, 9.403 kg ha^{-1} average yield and 6.000.000 tons of production value (FAO, 2019). The corn produced in the world is used % 70 for animal feeding, 25% for human nutrition and 5% as industrial raw material (Kocak, 1987).

Intensive fertilization is required for a good yield from the corn plant. Especially nitrogen fertilization has an important place in corn production (Adediran et al. 1995). Consumption of artificial (chemical) fertilizers is increasing rapidly due to the fact that the soils in Turkey are poor in terms of organic matter content.

It is a known fact that intensive chemical fertilization decreases the yield instead of increasing it (Berenguer et al. 2009). On the other hand, it is known that these chemical fertilizers given to the soil have negative effects on the environment and human health (Pimentel, 1996).

Organic fertilizers contribute to the nutrient content of the soil (Palm et al. 2001). In addition, the excess amount of organic matter in organic fertilizers improves soil structure and increases water retention capacity, and increases microbial activity (Haynes and Naidu, 1998).

This study was carried out in Kahramanmaras province in order to reveal the changes in the yield components and the chemical content of the corn grain by using different organic fertilizers (cattle manure, leonardite and vermicompost) and their different doses. Fertilizers were applied in 2018, and the following year were not given, and also the residual effects of the organic fertilizers left over from the previous year were examined.

Material and Methods

The Helen hybrid corn variety was used in the experiment, which belongs to the FAO 650 maturity group.

Soil characteristics of the field area

Soil samples were taken from 9 different points at a depth of 0-30 cm from the field of the study in 2018, before planting. It has been analysed in terms of nutrients in the soil in KSU USKIM (Centre for University and Industry Collaboration) (Table 1) (Anonymous, 2018).

Table 1. Some physical and chemical properties of treatment area soil (0-30cm)

Parameters	Grade
Calcium (Ca) ppm	3819
Magnesium (Mg) ppm	1194
Potassium (K) ppm	147.5
Sodium (Na) ppm	9.9
Iron (Fe) ppm	2.53
Zinc (Zn) ppm	0.37
Manganese (Mn) ppm	2.04
Copper (Cu) ppm	1.79
pH	7.71
Lime ($CaCO_3$) %	3.90
Salt %	0.11
HA gcm^{-3}	1.44
Clay%	32.50
Silt%	16.00
Sand%	51.50
Texture	SCL
Organic matter %	1.41

Climatic characteristics of the treatment area

The Experimental Area of KSU Faculty of Agriculture Field Crops Department is located at 37°35'38.2"N, 36°48'51.2"E coordinates. In the province of Kahramanmaras where the research was conducted, typical Mediterranean climate is

dominant and the summers are hot and dry, and the winters are warm and rainy (Table 2) (MGM, 2021).

Table 2. Some climate data of the cultivation periods (2018 and 2019) and long years average (1930-2020) in Kahramanmaras province (MGM, 2021)

Year	Month	Temperature (°C)			Precipitation (mm)
		Aver.	max	min	Total per month
2018	April	17.90	27.70	9.50	48.80
2019		14.16	29.45	0.81	32.20
Long years		15.10	21.20	9.80	73.0
2018	May	21.40	30.90	13.60	1.60
2019		23.01	41.31	1.75	3.60
Long years		20.00	26.80	14.0	38.80
2018	June	25.50	33.70	19.00	17.0
2019		27.15	43.44	11.41	5.20
Long years		24.90	31.90	18.70	8.60
2018	July	28.90	36.30	22.90	2.20
2019		30.17	45.20	20.40	1.80
Long years		28.20	35.70	22.10	2.70
2018	August	29.30	37.50	22.90	0.40
2019		30.08	46.30	21.30	0.20
Long years		28.40	36.10	22.20	2.20

Experimental design

The research was carried out in a Randomized Complete Block Design (RCBD) combined two years with 3 replications. The plots areas in the experiment were 2.8 m x 5.0 m = 14.0 m^2. Distances were 1.5 m between the blocks and 1 meter between the plots. Organic fertilizers (Cattle Manure, Leonardite and Vermicompost) were applied at doses of 2.500, 5.000, 7.500 and 10.000 $kgha^{-1}$ (Table 3).

Table 3. Contents of organic fertilizers used in the research

Organic fertilizers	Organic Matter (%)	Total N (%)	Total P_2O_5 (%)	EC (dS/m)	pH
Cattle manure	61.0	0.35	0.10	2.1	7.7
Leonardite	55.0	1.40	0.17	1.3	6.0
Vermicompost	56.1	2.20	0.46	3.6	6.5

In conventional agriculture application, Urea (46% N) and Diammonium phosphate (18% N - 46% P_2O_5) fertilizers (250 kg nitrogen and 100 kg phosphorus per hectare) were used. All fertilizer applications were carried out in 2018, and no fertilizers were applied in 2019 to assess the residual effects. The planting process was carried out on April 10 in 2018 and on April 12 in 2019 with a plot drill. Drip irrigation method was used for plant water needs. In both years, field measurements and harvesting were completed at the end of August.

Measurements

In the examination of agronomical characteristics, 10 plants were taken randomly from each plot and the following measurement procedures were carried out as stated by the other researchers (Kara and Kırtok, 2006; Sarıyerli and Soylu, 2016; Demir and Konuskan, 2016; Idikut ve Senol, 2018). *Plant Height (cm):* The distance from the soil surface to the tassel of the maize plants were measured in cm. *Diameter of the cob (mm):* It was measured as "mm" with a caliper tool from the middle point of the corn cob. *Grain weight on the cob (g):* The grains of 10 samples taken randomly from each plotl were weighed and averaged. *1000 grain weight (g):* 100 grains were randomly counted from the corn grains 4 times and weighed on a precision scale. Their averages were calculated by multiplying them by 10. *Grain yield (kg ha^{-1}):* The cobs obtained from each plot were grained, then the moisture content of the weighed grains was measured, the values were adjusted to 14% moisture content and the grain yield per hectare was determined. *Oil ratio (%):* It was determined by Soxhlet device according to the extraction method as specified by Min and Ellefson (2010). *Protein ratio (%):* It was determined according to the Dumas method according to the methods and principles stated by Chang (2010). *Starch ration (%):* It was determined as specified by BeMiller (2010) based on HPLC (high-performance liquid chromatography) method.

Statistical analysis

The results of the research were subjected to analysis of variance according to the RCBD design with the SAS statistical package program (v.9.1).

Statistical analysis was performed on the basis of both one-year and two-year averages on the data from 2018 and 2019. In comparing the difference between the means, LSD (Least Significant Difference) multiple comparison tests were used (SAS, 2004).

Results and Discussion

Plant height (cm)

While the first year (2018) values were found to be statistically significant, the second year (2019) values were statistically insignificant in terms of plant height (Table 4). On the other hand, the highest value was from traditional farming practice in both 2018 and 2019 and the two-year average (219.50 cm, 141.87 cm and 180.72 cm, respectively).

On the other hand, the highest value was followed by the 75.000 kgha^{-1} dose of vermicompost. In this practice, plant height values were found to be 209.57 cm in 2018, 141.7 cm in 2019 and 175.63 cm in two-years average. Plant height is a feature determined by the influence of environmental factors as well as genetic factors. It is also reported in other studies that plant height varies according to fertilizer type and fertilizer doses (Dogan and Yurur 1992, Tepecik et al., 2014).

Table 4. Average values of maize plant height (cm) and Cob diameter (mm) according to different organic fertilizer applications and their LSD multiple comparison test groups

Fertilizer application	Plant height (cm)			Cob diameter (mm)		
	2018	2019	2-Year Aver.	2018	2019	2-Year Ave.
1.Control	193.30 f	133.73	163.52 C-E	32.91 d	34.77	33.84 C
2. Cattle manure 250	193.10 f	126.00	159.55 DE	35.18 cd	33.21	34.19 BC
3. Cattle manure 500	201.93 e	129.27	165.60 B-E	37.69 abc	35.63	36.66 A-C
4. Cattle manure 750	204.83 d	121.90	163.37 C-E	41.80 a	36.71	39.25 A
5. Cattle manure 1000	202.00 e	134.70	168.35 B-E	37.84 abc	35.17	36.51 A-C
6. Leonardite 250	199.93 e	123.03	161.48 C-E	39.06 abc	35.72	37.39 AB
7. Leonardite 500	200.90 e	135.10	168.00 B-E	38.24 abc	36.76	37.50 AB
8. Leonardite 750	201.53 e	114.20	157.87 E	37.06 bcd	34.21	35.64 BC
9. Leonardite 1000	208.70 b	131.30	170.00 B-D	36.11 cd	31.06	33.59 C
10. Vermicompost 250	208.13 bc	126.43	167.28 B-E	35.64 cd	34.80	35.22 BC
11. Vermicompost 500	205.90 cd	131.50	168.70 B-D	34.88 cd	35.98	35.43 BC
12. Vermicompost 750	209.57 b	141.70	175.63 AB	38.97 abc	35.88	37.42 AB
13. Vermicompost 1000	209.47 b	131.80	170.63 BC	38.39 abc	35.52	36.96 A-C
14. Conventional	219.50 a	141.87	180.72 A	41.10 ab	37.65	39.38 A
Average	204.25 A	130.18 B	167.20	37.49 A	35.22 B	36.36

Means denoted by a different letter indicate significant differences between treatments.

Plant height were found to be higher in first year compared with second year. This situation may be attributed to the applied nutrients in the first year decreased over time. The fact that the plant height tends to decrease in direct proportion with the decrease in nutrients is due to the decrease in the substances required for growth. Similar views were reported by Sayed and Sadni (1984). On the other hand, it was reported by Beyene et al. (2005) that plant height values have a wide variation. Atasever et al. (2020) reported that the height of the corn plant is an inherited trait that is affected by the environment and growing conditions. It has been reported that organomineral and chemical fertilizers have a positive effect (Ayeni et al. 2012; Kmetova and Kovacik 2014). On the other hand, our findings are in agreement with Oktem and Toprak (2013).

Cob diameter (mm)

In 2018, the highest cob diameter value was obtained from 7.500 kgha^{-1} dose of cattle manure (41.80 mm). In 2019, although not statistically significant, the highest value was found in conventional application (37.65 mm). The highest value in terms of two-year average was obtained from the application of conventional agriculture techniques with 39.38 cm (Table 4). However, in terms of the two-year average, 7.500 kgha^{-1} dose of cattle manure (39.25 mm) and more than one

application following it were in the same statistical group with the highest value. Considering the averages in terms of years, the first year of fertilizers had a higher average value (37.49 mm) than the second year (35.22 mm). The fertilizer need of the corn plant is quite high, and the effect of the decreasing nutrient material has also been evident in the cob diameter. It has been reported that the diameter of the cob of the corn plant varies according to the environmental conditions (Kusaksiz and Kusaksiz, 2018).

Grain weight of cob (g)

The average grain weight value (111.46 g) in the first year when the fertilizers were given to the treatment area was found to be quite high compared to the second year (69.70 g) (Table 5).

Table 5. Average values of maize grain weight of Cob (g) and thousand grain weight (g) according to different organic fertilizer applications and their LSD multiple comparison test groups

Fertilizer app.	Grain weight of Cob (g)			Thousand grain weight (g)		
	2018	2019	2-Year Aver.	2018	2019	2-Year Ave.
1.Control	59.00 e	65.33	62.17 D	221.66	252.55	237.10
2. Cattle manure 250	88.33 de	60.33	74.33 DC	239.91	267.62	253.77
3. Cattle manure 500	112.67 a-d	72.52	92.59 A-C	258.42	251.01	254.72
4. Cattle manure 750	136.17 ab	75.33	105.75 AB	259.12	258.85	258.99
5. Cattle manure 1000	102.00 b-d	67.44	84.72 B-D	241.04	249.93	245.49
6. Leonardite 250	120.00 a-d	70.96	95.48 A-C	255.86	254.97	255.41
7. Leonardite 500	119.50 a-d	77.00	98.25 A-C	254.12	257.65	255.89
8. Leonardite 750	127.67 a-c	60.22	93.94 A-C	259.97	241.12	250.54
9. Leonardite 1000	110.77 b-d	53.67	82.22 B-D	246.19	256.95	251.57
10. Vermicompost 250	92.67 c-e	70.33	81.50 B-D	266.65	222.12	244.39
11. Vermicompost 500	98.17 cd	76.52	87.34 BC	264.33	246.46	255.40
12. Vermicompost 750	121.33 a-d	77.81	99.57 AB	270.45	251.93	261.19
13. Vermicompost 1000	124.33 a-d	62.00	93.17 A-C	261.71	258.85	260.28
14. Conventional	147.83 a	86.33	117.08 A	260.73	250.51	255.62
Average	111.46 A	69.70 B	90.58	254.30	251.47	252.88

Means denoted by a different letter indicate significant differences between treatments.

In terms of fertilizer applications, conventional fertilizers had the highest values in both 2018 and 2019 and in terms of two-year averages (147.83 g, 86.33 g and 117.08 g, respectively). Among organic fertilizers, 7.500 kg ha^{-1} application of cattle manure had the highest values in both years and two years averages (136.17 g, 75.33 g and 105.75 g, respectively). Although conventional fertilization application had the highest values, organic fertilizers are also included in the same statistical group. The statistical differences in terms of grain weight of cob were mainly due to the types and amounts of fertilizers. It has been reported that the grain weight of the cob varies according to the fertilizer doses (Dudenhoeffer et al. 2013).

Thousand grain weight (g)

The difference between the years in terms of thousand grain weight and all the differences between applications were found to be statistically insignificant. However, the first-year value (254.30 g) was determined to be higher than the second year (251.47 g) (Table 5). It has been reported in other studies that the changes in thousand grain weight according to fertilizer doses and fertilizer application times are statistically insignificant (Idikut and Kara, 2011; Timon et al. 2020). On the other hand, 7.500 $kgha^{-1}$ dose of vermicompost had the maximum thousand grain weight (261.19 g) according to the average of two years. Thousand grain weight value is determined by genetic structure, although it is affected by environmental conditions. Our findings are in agreement with Onasanya et al. (2009) and Palta et al. (2011).

Grain yield (kg ha^{-1})

While the average grain yield, which is one of the basic elements in the research, was realized as 4940 $kgha^{-1}$ in 2018, it decreased to 1667.4 $kgha^{-1}$ in 2019 (Table 6). In this study, in which it is

aimed to see the effect of fertilizer by giving it in the first year; Grain yield also tended to decrease due to the decreasing amount of nutrients (Figure 1). Maize is a plant that needs a lot of nutrients and the decrease in nutrients causes very high yield decreases. Decrease in grain yield with the decrease in nutrients was also reported by other researchers (Taye et al. 2015). On the other hand, it has been reported that different yield values were obtained in maize plants according to years (Dogan et al. 2019).

Table 6. Average values of maize grain yield (kg/ha) and protein ratio (%) According to different organic fertilizer applications and their LSD multiple comparison test groups

Fertilizer App.	Grain Yield (kg/ha)			Protein Ratio (%)		
	2018	2019	2-Year Aver.	2018	2019	2-Year Aver.
1.Control	1711.6 d	1714.3	1712.9 D	6.32	6.32 a-d	6.32 BC
2. Cattle manure 250	4088.9 c	1452.3	2770.6 C	6.68	6.90 ac	6.79 A-C
3. Cattle manure 500	4673.6 bc	1666.6	3170.1 BC	7.00	6.65 a-d	6.82 A-C
4. Cattle manure 750	5515.4 a-c	1738.1	3626.7 A-C	6.85	6.65 a-d	6.75 A-C
5. Cattle manure 1000	5101.8 bc	1726.1	3414.0 BC	7.34	6.46 a-d	6.91 A-C
6. Leonardite 250	4651.9 bc	1452.4	3052.1 BC	6.60	6.05 b-d	6.33 BC
7. Leonardite 500	5331.9 a-c	1904.7	3618.3 A-C	6.92	5.74 b-d	6.33 BC
8. Leonardite 750	4737.3 bc	1583.3	3160.3 BC	7.08	5.45 cd	6.27 BC
9. Leonardite 1000	4617.2 bc	1629.5	3123.4 BC	6.76	5.12 d	5.94 C
10. Vermicompost 250	4613.0 bc	1273.8	2943.4 BC	7.79	7.74 a	7.77 A
11. Vermicompost 500	5588.6 a-c	1880.9	3734.8 A-C	7.47	7.33 ab	7.40 A
12. Vermicompost 750	5414.8 a-c	1833.3	3624.1 A-C	6.94	7.29 ab	7.12 AB
13. Vermicompost 1000	6167.9 ab	1630.9	3899.4 AB	7.57	7.06 ab	7.31 AB
14. Conventional	6976.5 a	1857.1	4416.8 A	7.55	6.02 b-d	6.78 A-C
Average	4942.2 A	1667.4 B	3304.8	7.06 A	6.48 B	6.77

Means denoted by a different letter indicate significant differences between treatments.

When the years are evaluated within themselves, conventional application (6976.5 kgha^{-1}) has the highest yield value in 2018, but there was more than one value in the same statistical group. With conventional fertilizer application, vermicompost 10.000 kgha^{-1} (6167.9 kgha^{-1}), vermicompost 5.000 kgha^{-1} (5588.6 kgha^{-1}), cattle manure 7.500 kgha^{-1} (5515.4 kgha^{-1}), leonardite 5.000 kgha^{-1} (5331.9 kgha^{-1}) applications were also included in the same statistical group. Although the differences in grain yield values between applications in 2019 were statistically insignificant, the highest value was obtained from the 5.000 kgha^{-1} application of leonardite (1904.7 kgha^{-1}). When the two-year averages are evaluated, conventional fertilizer application has the highest yield value (4416.8 kgha^{-1}) (Table 6). On the other it was reported that the yield increased depending on the amount of organic fertilizer (Nasab et al. 2015).

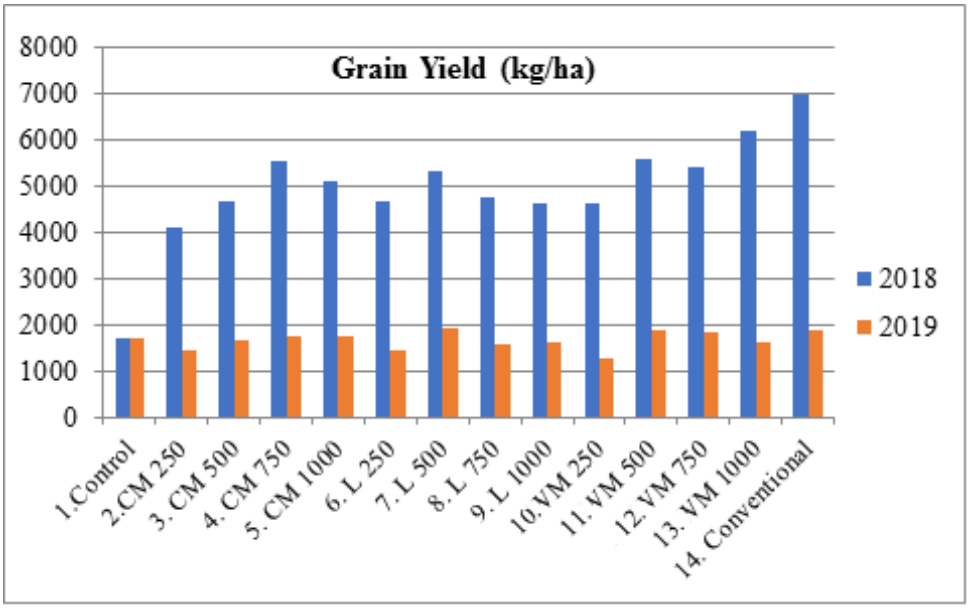

Figure 1. Variation of grain yield in corn plant according to fertilizers and years

Organic fertilizers are important for improving the physical and chemical properties of the soil (Parja and Kumar, 2013). On the other hand, in studies conducted with organic fertilizers, it has been reported that chemical fertilizers have higher yield values (Warman and Havard 1998). Waniyo et al. (2013) reported that cattle manure application was the most affected the growth, yield and nutrient intake of the corn plant. Brown et al. (1995) compared inorganic manure and chicken manure, and they obtained more efficiency from chicken manure. On the other hand, they reported the positive effect of leonardite on yield and yield components (Saglam et al 2012). Our findings are in agreement with previous studies (Takil et al. 2020; Gonulal et al. 2021).

Protein ratio (%)

Protein ratio values obtained from maize plants were higher in the first year (7.06%) and lower in the second year (6.48%) (Table 6). Although the protein ratio is determined by genetic factors, it is also affected by environmental conditions. It has been reported that the increase in the amount of nutrients in the soil has a positive effect on protein synthesis (Getmantes et al. 1981). The difference between applications in 2018 was statistically insignificant. It has been reported that the effect of fertilizer types on protein ratio is insignificant (Elmali, 2007; Dogan et al. 2020). In 2019, although there was more than one value in the same statistical group, the highest value was obtained from the 2.500 $kgha^{-1}$ dose of vermicompost (7.74%). It was reported that the protein ratio increased in direct proportion to the increasing dose of vermicompost (Tavali et al. 2014).

Oil ratio (%)

In terms of oil ratio, the value of the first year of fertilizer applications (1.89%) was found to be quite low compared to the second year (2.76%) (Table 7). This situation reveals that the effect of fertilizers on oil content occurs after the breakdown of fertilizers. Considering 2018 and the two-year averages; differences between fertilizer applications were found to be statistically insignificant. It has been reported that the effect of organic and inorganic fertilizers on the oil content is insignificant (Dogan et al. 2020). In 2019, vermicompost had the highest values at 5.000 $kgha^{-1}$ (3.16%) and vermicompost at 2.500 $kgha^{-1}$ (3.12%), but there is more than one value in the same statistical group.

Table 7. Average Values of Maize Oil Ratio (%) and Starch Ration (%) According to Different Organic Fertilizer Applications and Their LSD Multiple Comparison Test Groups

Fertilizer App.	Oil Ratio (%)			Carbohydrate Ratio (%)		
	2018	2019	2-Year Aver.	2018	2019	2-Year Aver.
1.Control	2.09	2.33 c	2.21	70.55	78.87 a-c	74.71 AB
2. Cattle manure 250	2.33	2.42 c	2.38	69.99	78.26 a-e	74.12 A-D
3. Cattle manure 500	1.70	2.58 a-c	2.14	70.08	78.36 a-e	74.22 A-D
4. Cattle manure 750	1.75	2.46 bc	2.11	70.35	78.48 a-e	74.42 A-C
5. Cattle manure 1000	1.75	2.47 bc	2.11	69.48	78.61 a-d	74.04 A-D
6. Leonardite 250	1.60	2.79 a-c	2.19	70.85	78.77 a-d	74.81 AB
7. Leonardite 500	2.22	2.75 a-c	2.49	69.75	79.10 ab	74.43 A-C
8. Leonardite 750	1.92	2.92 a-c	2.42	69.65	79.24 ab	74.45 A-C
9. Leonardite 1000	1.73	2.80 a-c	2.27	70.33	79.69 a	75.01 A
10. Vermicompost 250	1.92	3.12 a	2.52	69.02	76.81 e	72.92 D
11. Vermicompost 500	1.79	3.16 a	2.48	69.39	77.10 de	73.24 CD
12. Vermicompost 750	1.91	3.06 ab	2.49	69.75	77.22 c-e	73.48 B-D
13. Vermicompost 1000	1.83	2.90 a-c	2.36	68.88	77.64 b-e	73.26 CD
14. Conventional	1.91	2.91 a-c	2.41	68.84	78.70 a-d	73.77 A-D
Average	1.89 B	2.76 A	2.33	69.78 B	78.35 A	74.06

Means denoted by a different letter indicate significant differences between treatments.

Starch ration (%)

The starch ration values were found to be lower in the first year (69.78%) and higher in the second year (78.35%) (Table 7). This situation could be attributed to no fertilization in the second year. When the years are evaluated within themselves, while the differences between the applications in 2018 were found insignificant, the 10.000 $kgha^{-1}$ application of leonardite gave the highest value in 2019 and in terms of the two-year average (79.69% and 75.01% respectively). However, there were more than one value in the same statistical group. The use of leonardite has also provided a high rate of carbohydrates. A high starch ration is especially necessary for a good silage production (Schmid et al. 1976). They reported positive effects of vermicompost in terms of quality properties (Kovacik, 2014).

Conclusion

In this study, the effects of different organic materials such as cattle manure, vermicompost and leonardite on the growth and quality features of maize plants were investigated. The obtained data were compared among themselves and with conventional production application and non-fertilized production application. According to the research results, maize grain yield decreased in 2019 compared to 2018 data in all treatments since fertilizer was not applied in the second year. The closest values of the maize grain yield that they were statistically in the same group, obtained from conventional fertilizer applications of Vermicompost 500, 750 and 1000, Cattle Manure 750 and Leonardite 500 in 2018 year. There were no statistically significant differences between applications in 2019 in terms of grain yield. On the other hand, the vermicompost treatments had the highest values for the oil ratio and protein ratio, also the leonardite had the highest value for the starch ration. Generally, the highest values in terms of the other plant characteristics and grain yield were found in chemical fertilizer applications.

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