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THE EFFECTS OF FERTILIZER AND DIFFERENT SOIL CONDITIONER TO YIELD AND YIELD COMPONENTS IN CHICKPEA CULTIVARS

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Abstract: This study was carried out in Kahramanmaraş Sütçü İmam University Faculty of Agriculture Research treatment area in 2022. In the study, 14 different fertilizer applications (no fertilizer, chemical fertilizer, olive bagasse 100 kg/da, olive bagasse 200 kg/da, olive bagasse 400 kg/da, olive bagasse 600 kg/da, worm manure 100 kg/da, worm manure 200 kg/da, worm manure 400 kg/da, worm manure 600 kg/da, leonardite manure 100 kg/da, leonardite manure 200 kg/da, leonardite manure 400 kg/da, leonardite manure 600 kg/da) were made in 2 different chickpea cultivars (Aras, Katran). According to the results obtained from the study, Katran variety had higher grain yield than Aras variety, but 1000 grain weight was found to be lower. On the other hand, the highest grain yield was obtained from olive bagasse 200 kg/da application.

Keywords: Fertilizer, Chickpea cultivars, Yield, Components

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1. Introduction

Agriculture has been the foundation of national economies worldwide. It has achieved significant success, thanks to advancements in science, technology, and the intensive use of land. However, it has also brought about certain agro-ecological and environmental challenges. The widespread use of chemical fertilizers and pesticides in agriculture has resulted in land degradation and environmental pollution in various agricultural ecosystems. The continuous application of chemical fertilizers to agricultural lands has deteriorated soil fertility, leading to a reduction in biodiversity, soil organic matter content, and causing irreversible soil erosion (Yasir et al., 2022). In contrast, organic fertilizers enhance soil organic matter content, soil fertility, microbial activity, and moisture retention capacity (Demirkıran et al., 2012; Meagy et al., 2016). They improve soil quality and crop yield by serving multiple functions in agricultural ecosystems (Jones et al., 2007; Ekici et al., 2023). Organic matter enhances soil quality by improving input use efficiency and ensuring optimum sustainability and environmental safety (Kushwah et al., 2016). The application of organic fertilizer increases soil fertility and, consequently, crop yield (Reddy et al. 2005). Many studies state that organic wastes improve soil structure, increase soil organic matter content, reduce evaporation, and are effective against erosion (Laamrani et al., 2017; Liang et al., 2012). The application of organic fertilizer enhances soil quality and health by increasing soil carbon and microorganisms beneficial to plant crops (Gaind and Singh, 2016). The protein content of wheat grown with organic fertilizers is higher than that of wheat grown with chemical fertilizers (Bahrman et al., 2004; Shivay et al., 2010). Foods produced with organic fertilizers are known to be tastier and have a more balanced vitamin and mineral content than conventionally grown foods (Fuertes-Mendizabal et al., 2010). Organic production is an economical, renewable, and environmentally friendly approach that allows the preservation of natural resources for current and future generations, ensuring the sustainability of production.

Leonardite is a low-calorie coal rich in humic acid and organic matter and formed as a result of the oxidation of lignite coal without coalification (Olivella et al., 2002). Leonardite, an organic regulator, improves the structure of the soil, increases water retention capacity and water permeability, maintains soil moisture content and maintains soil pH balance (Kara et al., 2022a). Vermicompost has positive effects on the physical (aggregate stability, water retention), chemical (plant

nutrition elements, soil pH), biological properties (living diversity and biomass) and plant productivity of soils (Dominguez et al., 2003; Ferreras et al., 2006; Azarmi et al., 2008; Saha et al., 2008). Olive bagasse is the solid sub-product remaining after the mechanical processing of olives into oil. When applied to soils as an organic regulator, it improves the physical properties of soils (hydraulic conductivity, aggregate stability, dispersion ratio, field capacity and bulk density) (Kara et al., 2022b). In this study, we investigated the effects of different organic fertilizers (leonardite, worm manure, and olive bagasse) on the yield and quality of chickpea varieties (Aras and Katran).

2. Materials and Methods

This research; in order to determine the yield and yield characteristics of local chickpea genotypes and registered chickpea varieties were conducted in the Kahramanmaras in 2022 year with Aras and Katran chickpea varieties. It was conducted in the Research and Application area of Kahramanmaraş Sutçu Imam University, Faculty of Agriculture (it's coordinate 37S X: 307001, Y: 41630333). Wheat plants have been planted before in the area where the study is located. The area of each parcel was determined as $10m^2$ (5m × 2m). The study was conducted as a randomized completely block design with three replications. In the study, no fertilizer, chemical fertilizer, olive bagasse 100 kg/da, olive bagasse 200 kg/da, olive bagasse 400 kg/da, olive bagasse 600 kg/da, worm manure 100 kg/da, worm manure 200 kg/da, worm manure 400 kg/da, worm manure 600 kg/da, leonardite 100 kg/da, leonardite 200 kg/da, leonardite 400 kg/da, leonardite 600 kg/da fertilizer applications were made.

Harvesting operations were done manually. Weeds were physically combated throughout the growing period. On the other hand, chemical control was carried out against diseases and pests. Some physical and chemical properties of the soil used as a trial area are given in Table 1. In addition, some chemical properties of the organic fertilizers used as materials (Olive Bagasse, Worm manure and Leonardite) are given in Table 2.

Table 1. Some physical and chemical properties of the soil where the experiment was established

Sand	Clay	Silt	pH	OM	Lime	P	K
%	%	%		%	%	µg/g	µg/g
41	30	29	7.62	1.68	3.2	13.8	230

Table 2. Some chemical properties of organic regulators

Variables	Leonardite (Kara and Yakupoğlu, 2023)	Olive Bagasse (Kara et al., 2022b)	Worm Manure
OM (%)	55	84.1	52.4
C (%)	31.9	48.14	30.39
N (%)	0.54	1.02	2.06
P (µg/g)	1781	900	4600
K (µg/g)	4170	12000	.....
Ca (µg/g)	92100	2800	.....
Mg (µg/g)	2087	1100	.....
Fe (µg/g)	2780	305.6	.....
Zn (µg/g)	28.26	30.1	.....
Mn (µg/g)	25.88	25.2	.....
Cu (µg/g)	0.9	.....	.....

2.1. The climate characteristic of the study area

The summers in Kahramanmaraş city center are hot and dry, and the winters are warm and rainy. The average temperature and total precipitation values for the year the experiment was conducted are given in Table 3. As reported by other researchers in the study; plant height (cm), first pod height (cm), number of pods per plant (number/plant), 1000 seed weight (g) and seed yield (kg/da) parameters were examined (Colkesen *et al.,* 2014; Girgel *et al.* 2018; Girgel and Cokkizgin, 2019).

2.2. Statistical Analysis

The data obtained from study were analyzed according to one factor randomized complete block design using the SAS package program (SAS, 2004). LSD multiple range test was used to compare the means.

Table 3. Climate data obtained from Kahramanmaraş meteorological station (Anonymous, 2022)

	Monthly Total Precipitation (mm)	Monthly Total Precipitation (mm)	Monthly Average Temperature (°C)	Monthly Average Temperature (°C)
Months	2022	1930-2018	2022	1930-2018
January	311.2	4.9	4.47	4.9
February	170.4	6.5	8.7	6.5
March	157.8	10.7	7.1	10.7
April	12.7	15.5	18.2	15.5
May	40.4	20.3	20.4	20.3
June	3.7	25.2	26.1	25.2
July	0.5	28.4	29.6	28.4
August	0	28.5	29.4	28.5
September	10.7	25.2	26.1	25.2
October	12.3	19.1	20.6	19.1
November	72.4	11.7	13.4	11.7
December	32.5	6.7	9.6	6.7
Total	824.6	725.8	....	....
Mean	....	....	17.8	16.9

3. Results and Discussion

3.1. Plant Height (cm)

Variance analysis table for plant height are given in Table 4. According to the results obtained from the research, different fertilizer applications and different fertilizer X chickpea interaction were found to be insignificant. The statistical difference between chickpea varieties was found to be significant.

In terms of plant height, Aras variety produced taller plants than Katran variety (Table 6).On the other hand, when the situation is evaluated in terms of chemical applications, the highest plant height value was obtained from leonardite fertilizer 600 kg/da application (Table 6). Generally similar results were obtained when looking at other organic fertilizer application doses (CF, OB 100kg/da, OB 200kg/da, OB 400kg/da, OB 600kg/da, WM 100kg/da, WM 200kg/da, WM 400kg/da; WM 600kg/da, L 100kg/da, L 200kg/da, L 400kg/da). The results obtained from the study are in agreement with other studies (Bakoğlu, 2005; Ekici et al., 2023). Ekici et al. (2023) determined plant height of chickpea between 48 cm and 54 cm with using leonardite and stated that increases in plant height were insignificant.

When the varieties (Aras and Katran) are evaluated within themselves; differences between fertilizer applications were statistically insignificant. Similar opinions reported by Colkesen et al. (2014), Girgel et al. (2018), Girgel and Cokkizgin (2019).

Table 4. Variance analysis table for plant height

Variation Source	DF	SS	MS	F	Prob.
Different Fertilizer Application	13	121.6234155	9.3556473	1.09	0.3833
Chickpea Cultivars	1	62.7644298	62.7644298	7.34	0.0089
Different Fertilizer X Chickpea Interaction	13	42.5274536	3.2713426	0.38	0.9701
Error	56	479.0024000	8.5536143		
Total	83	705.9176988			

DF= degrees of freedom , SS= sum of squares , MS= mean sum of squares , F= F-statistic, Prob= probability

Table 5. Plant height values of cultivars and statistical groups

Cultivars	Means
Aras	48.4660[a]
Katran	46.7371[b]

[a,b] Means with different letters in the same column are significantly different at P<0.05.

Table 6. Plant height (cm) values of different fertilizer applications and statistical groups

DFA	Aras	Katran	Mean
Control	50.043 ND	46.587 ND	48.315 ND
CF	48.587 ND	45.127 ND	46.857 ND
OB 100 kg/da	49.000 ND	45.083 ND	47.042 ND
OB 200 kg/da	47.460 ND	45.377 ND	46.418 ND
OB 400 kg/da	46.670 ND	45.210 ND	45.940 ND
OB 600 kg/da	45.917 ND	47.293 ND	46.605 ND
WM 100 kg/da	47.127 ND	46.170 ND	46.648 ND
WM 200 kg/da	48.503 ND	48.917 ND	48.710 ND
WM 400 kg/da	47.583 ND	46.253 ND	46.918 ND
WM 600 kg/da	49.127 ND	46.627 ND	47.877 ND
L 100 kg/da	48.417 ND	47.627 ND	48.022 ND
L 200 kg/da	49.337 ND	46.833 ND	48.085 ND
L 400 kg/da	49.253 ND	47.087 ND	48.170 ND
L 600 kg/da	51.500 ND	50.130 ND	50.815 ND

ND= non differences, DFA= different fertilizer application, CF= chemical fertilizer, OB= olive bagasse, WM= worm manure, L= leonardite

3.2. First Pod Height (cm)

Variance analyses for first pod height are given in Table 7. In terms of first pod height, different fertilizer applications and different fertilizer X chickpea interaction were found to be insignificant. But chickpea cultivars variation source was found to be significant.

Worm manure (200 kg/da) application had highest the first pod height value in chickpea plant. Additionally, in all other applications, the initial pod height was similar (Table 8). When the varieties (Aras and Katran) are evaluated within themselves; differences between fertilizer applications were statistically insignificant. The results obtained from the study are in agreement with other studies (Bakoğlu, 2005). The results obtained from the study are in agreement with other studies (Kahraman, 2017). The average first pod height of Aras and Katran varieties is given in Table 9. Accordingly, the average first pod height of the varieties (Aras and Katran) was statistically significant.

Table 7. Variance analysis table for first pod height

Variation Source	DF	SS	MS	F	Prob.
Different Fertilizer Application	13	138.7596905	10.6738223	0.89	0.5667
Chickpea Cultivars	1	60.2149333	60.2149333	5.03	0.0289
Different Fertilizer X Chickpea Interaction	13	174.0771000	13.3905462	1.12	0.3640
Error	56	670.695800	11.976711		
Total	83	1043.747524			

DF= degrees of freedom , SS= sum of squares , MS= mean sum of squares , F= F-statistic, Prob= probability

Table 8. First pod height (cm) values of chemical applications and statistical groups

DFA	Aras	Katran	Mean
Control	21.710 ND	25.170 ND	23.440 ND
CF	21.710 ND	25.003 ND	23.357 ND
OB 100 kg/da	22.043 ND	23.920 ND	22.982 ND
OB 200 kg/da	21.420 ND	24.960 ND	23.190 ND
OB 400 kg/da	21.003 ND	23.167 ND	22.085 ND
OB 600 kg/da	21.380 ND	24.587 ND	22.983 ND
WM 100 kg/da	21.380 ND	24.297 ND	22.838 ND
WM 200 kg/da	31.710 ND	23.543 ND	27.627 ND
WM 400 kg/da	21.960 ND	23.17 ND	22.565 ND
WM 600 kg/da	21.460 ND	24.587 ND	23.023 ND
L 100 kg/da	23.127 ND	24.500 ND	23.813 ND
L 200 kg/da	22.003 ND	22.960 ND	22.482 ND
L 400 kg/da	22.503 ND	23.920 ND	23.212 ND
L 600 kg/da	20.670 ND	24.003 ND	22.337 ND

ND= non differences, DFA= different fertilizer application, CF= chemical fertilizer, OB= olive bagasse, WM= worm manure, L= leonardite.

Table 9. First pod height values of cultivars and statistical groups

Cultivars	Means
Aras	22.4343[b]
Katran	24.1276[a]

[a,b] Means with different letters in the same column are significantly different at P<0.05.

3.3. Pod Number Per Plant (number/plant)

Variance analysis table for pod number per plant are given in Table 10. According to the results obtained from the research, different fertilizer applications and different fertilizer X chickpea interaction were found to be insignificant. The statistical difference between chickpea varieties was found to be significant in terms of pod number per plant.

Worm manure (400 kg/da) application is the fertilizer application that creates the most pods in the research (Table 11). On the other hand, the Katran variety has higher pods than the Aras variety, and this is statistically significant (Table 12). The results obtained from the study are in agreement with other studies (Soysal et al., 2020). On the other hand when the varieties (Aras and Katran) are evaluated within themselves; differences between fertilizer applications were statistically insignificant in terms of pod number. Similar opinions reported by Colkesen et al. (2014), Girgel and Cokkizgin (2019). Similarly, Ekici et al. (2023) determined pod number of chickpea with using leonardite as 37-54 number/plant and stated that increases in pod number were not significant.

Table 10. Variance analysis table for pod number per plant

Variation Source	DF	SS	MS	F	Prob.
Different Fertilizer Application	13	2258.40735	173.72364	1.17	0.3252
Chickpea Cultivars	1	11945.98801	11945.98801	80.43	<.0001
Different Fertilizer X Chickpea Interaction	13	2471.55434	190.11956	1.28	0.2524
Error	56	8317.46660	148.52619		
Total	83	24993.41630			

DF= degrees of freedom , SS= sum of squares , MS= mean sum of squares , F= F-statistic, Prob= probability

Table 11. Pod number per plant values (number/plant) of different fertilizer applications and statistical groups

DFA	Aras	Katran	Mean
Control	44.377 [ND]	72.670 [ND]	58.522 [ND]
CF	40.583 [ND]	67.960 [ND]	54.272 [ND]
OB 100 kg/da	39.920 [ND]	69.170 [ND]	54.545 [ND]
OB 200 kg/da	37.797 [ND]	57.630 [ND]	47.712 [ND]
OB 400 kg/da	37.127 [ND]	62.710 [ND]	49.918 [ND]
OB 600 kg/da	38.920 [ND]	55.000 [ND]	46.962 [ND]
WM 100 kg/da	41.213 [ND]	63.000 [ND]	52.108 [ND]
WM 200 kg/da	38.837 [ND]	67.750 [ND]	53.295 [ND]
WM 400 kg/da	41.417 [ND]	95.290 [ND]	68.355 [ND]
WM 600 kg/da	44.293 [ND]	54.340 [ND]	49.315 [ND]
L 100 kg/da	38.543 [ND]	68.960 [ND]	53.752 [ND]
L 200 kg/da	42.463 [ND]	55.920 [ND]	49.192 [ND]
L 400 kg/da	41.793 [ND]	61.710 [ND]	51.752 [ND]
L 600 kg/da	49.630 [ND]	58.710 [ND]	54.170 [ND]

ND= non differences, DFA= different fertilizer application, CF= chemical fertilizer, OB= olive bagasse, WM= worm manure, L= leonardite.

Table 12. Pod number per plant values of cultivars and statistical groups

Cultivars	Means
Aras	41.208[b]
Katran	65.059[a]

[a,b] Means with different letters in the same column are significantly different at P<0.05.

3.4. 1000 seed weight (g)

Variance analysis table for 1000 seed weight are given in Table 13. In terms of 1000 seed weight, different fertilizer applications and cultivars were found to be significant but different fertilizer X chickpea interaction variation source was found to be insignificant.

Decare 200 kg olive bagasse application had a maximum weight of 1000 grains, among fertilizers. This was followed by the application of 200 kg of leonardite fertilizer per decare (Table 14). The Aras variety has higher 1000 seed weight than the Katran variety and this is statistically significant (Table 15). This situation is associated with the fact that the grain sizes of the Katran chickpea variety are smaller than the Aras variety. The results obtained from the study are in agreement with other studies (Kahraman, 2017). When the varieties are evaluated within themselves; Differences between fertilizer applications in Aras cultivar were statistically insignificant. However, the response of the Katran cultivar to fertilizer applications was found to be statistically significant. Olive Bagasse 200 kg/da application had the highest 1000 grain weight value for the Katran variety (282.83 g).

Table 13. Variance analysis table for 1000 seed weight

Variation Source	DF	SS	MS	F	Prob.
Different Fertilizer Application	13	12414.6770	954.9752	2.53	0.0083
Chickpea Cultivars	1	839292.1492	839292.1492	2223.30	<.0001
Different Fertilizer X Chickpea Interaction	13	3871.9638	297.8434	0.79	0.6683
Error	56	21139.8905	377.4980		
Total	83	876718.6805			

DF= degrees of freedom , SS= sum of squares , MS= mean sum of squares , F= F-statistic, Prob= probability

Table 14. 1000 seed weight values (g) of chemical applications and statistical groups

DFA	Aras	Katran	Mean
Control	435.29 ND	225.12 ^{B}	330.20 ^{BC}
CF	416.55 ND	226.68 ^{B}	321.61 ^{BC}
OB 100 kg/da	428.01 ND	227.34 ^{B}	327.67 ^{BC}
OB 200 kg/da	454.26 ND	282.83 ^{A}	368.55 ^{A}
OB 400 kg/da	425.33 ND	234.07 ^{B}	329.70 ^{BC}
OB 600 kg/da	436.88 ND	219.96 ^{B}	328.42 ^{BC}
WM 100 kg/da	438.19 ND	224.29 ^{B}	331.24 ^{BC}
WM 200 kg/da	430.92 ND	225.64 ^{B}	328.28 ^{BC}
WM 400 kg/da	441.89 ND	222.75 ^{B}	332.32 ^{BC}
WM 600 kg/da	429.14 ND	222.19 ^{B}	325.67 ^{BC}
L 100 kg/da	409.7 ND	227.37 ^{B}	318.54 ^{BC}
L 200 kg/da	434.63 ND	246.99 ^{B}	340.81 ^{B}
L 400 kg/da	412.53 ND	217.65 ^{B}	315.09 ^{C}
L 600 kg/da	431.44 ND	223.06 ^{B}	327.25 ^{BC}

^{A,B,C} Means with different letters in the same column are significantly different at P<0.05. ND= non differences, DFA= different fertilizer application, CF= chemical fertilizer, OB= olive bagasse, WM= worm manure, L= leonardite.

Table 15. 1000 seed weight values of cultivars and statistical groups

Cultivars	Means
Aras	430.340^{s}
Katran	230.424^{b}

^{a,b} Means with different letters in the same column are significantly different at P<0.05.

3.5. Seed Yield (kg/da)

Variance analysis table for seed yield are given in Table 16. According to the results in terms of seed yield, different fertilizer applications and different fertilizer X chickpea interaction were found to be insignificant. The statistical difference between chickpea varieties was found to be significant.

Decare 200kg olive bagasse application had the highest value in terms of grain yield. The second highest yield result (230.22 kg/da) was obtained in the parcels where 100 kg of leonardite fertilizer was applied per decare (Table 17). The positive effect of fertilizers on productivity is known (Uçar, 2019).

On the other hand, the Katran variety has higher seed yield (235.48 kg/da) than the Aras variety (198.63 kg/da), and this is statistically significant (Table 18).

When the varieties (Aras and Katran) are evaluated within themselves; differences between fertilizer applications were statistically insignificant. The results obtained from the study are in agreement with other studies (Bakoğlu, 2005). Our findings are in agreement with similar studies (Arora et al., 2003; Lopez-Bellido et al., 2004; Bakoğlu, 2005; Kamithi et al., 2009; Kahraman, 2017; Soysal et al., 2020; Ekici et al., 2023) (Table 18).

Table 16. Variance analysis table for seed yield

Variation Source	DF	SS	MS	F	Prob.
Different Fertilizer Application	13	8012.55668	616.35051	0.25	0.9958
Chickpea Cultivars	1	28524.11152	28524.11152	11.53	0.0013
Different Fertilizer X Chickpea Interaction	13	16586.51296	1275.88561	0.52	0.9055
Error	56	138572.1791	2474.5032		
Total	83	191695.3603			

DF= degrees of freedom , SS= sum of squares , MS= mean sum of squares , F= F-statistic, Prob= probability

Table 17. Seed yield values (kg/da) of different fertilizer applications and statistical groups

DFA	Aras	Katran	Mean
Control	220.22 ND	237.54 ND	228.88 ND
CF	190.15 ND	231.16 ND	210.65 ND
OB100 kg/da	212.56 ND	216.82 ND	214.69 ND
OB 200 kg/da	202.97 ND	265.72 ND	234.34 ND
OB 400 kg/da	180.97 ND	225.5 ND	203.24 ND
OB 600 kg/da	207.57 ND	214.92 ND	211.24 ND
WM 100 kg/da	210.7 ND	218.26 ND	214.48 ND
WM 200 kg/da	177.51 ND	250.85 ND	214.18 ND
WM 400 kg/da	222.31 ND	208.34 ND	215.33 ND
WM 600 kg/da	199.79 ND	220.12 ND	209.96 ND
L 100 kg/da	200.37 ND	260.06 ND	230.22 ND
L 200 kg/da	202.37 ND	257.57 ND	229.97 ND
L 400 kg/da	164.51 ND	240.42 ND	202.47 ND
L 600 kg/da	188.76 ND	249.45 ND	219.11 ND

ND= non differences, DFA= different fertilizer application, CF= chemical fertilizer, OB= olive bagasse, WM= worm manure, L= leonardite.

Table 18. Seed yield values of cultivars and statistical groups

Cultivars	Means
Aras	198.63 B
Katran	235.48 A

4. Conclusion

Considering the findings, organic regulators (worm manure, olive bagasse, leonardite) and application doses (100 kg/da, 200 kg/da, 400 kg/da and 600 kg/da) didn't show positive changes on plant yield quality. This situation may be due to the heterogeneous characteristics of the study area. On the other hand, when we compared chickpea varieties among themselves, the katran chickpea variety gave higher yield than the Aras variety. According to this result, Katran variety can be recommended to Kahramanmaraş region farmers.

In addition, the highest grain yield was obtained from 200 kg/da olive bagasse application. However, it is important to repeat the study in a homogeneous area in order to be able to talk more clearly about organic fertilizers (olive bagasse, leonardite and worm manure) and application doses.

Author Contributions

The percentage of the author(s) contributions is present below. All authors reviewed and approved final version of the manuscript.

	Z.K	C.Y.	A.C
C	40	30	30
D	40	30	30
S	40	30	30
DCP	30	40	30
DAI	40	30	30
L	50	20	30
W	80		20
CR	30	30	40
SR	80	10	10
PM	40	30	30
FA	40	30	30

C=Concept, D= design, S= supervision, DCP= data collection and/or processing, DAI= data analysis and/or interpretation, L= literature search, W= writing, CR= critical review, SR= submission and revision, PM= project management, FA= funding acquisition.

Conflict of Interest

The authors declared that there is no conflict of interest.

Ethical Consideration

Ethics committee approval was not required for this study because of there was no study on animals or humans.

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