OPEN ACCESS
Freely Available Online

OpenAccessPub

JOURNAL OF AGRONOMY RESEARCH

ISSN NO: 2639-3166

Research Article

DOI: 10.14302/issn.2639-3166.jar-20-3388

Response of Some Sunflower (*Helianthus annuus* L) Hybrid Cultivars as Influenced by Argel (*Solenostemma argel*, Del. Hayne) and Nitrogen Under Irrigation in Sudan

Abubaker H. M. Adam[1,*] Abdalla Adam Hassam Mohamed[2], Faiza M. A. Magid[3], Bahar Eldeen Z. Abakar[4], Mohamed M. A. Mohamed[5], Annas A. M. Al badawi[6]

[1]Department of Crop Science, College of Agriculture, University of Bahri- Khartoum North

[2]Ministry of Agriculture, Animal Wealth and Irrigation –Khartoum State- Sudan

[3]Department of Pests and Plant Health, College of Agriculture, University of Bahri, Khartoum North, Sudan

[4]Department of Crop Science, College of Agriculture, University of Bahri- Khartoum North Sudan

[5]Department of Crop Science, College of Agriculture, University of Bahri- Khartoum North Sudan

[6]Department of Crop Science, College of Agriculture, University of Bahri- Khartoum North Sudan

Abstract

A field experiment was conducted during 2017/2018 to assess the effects of Argel (*Solenostemma argel*, Del. Hayne) and Nitrogen fertilizer on the performance of two Sunflower Hybrid cultivars, with the objectives to exploit an easy, economic, and accessible organic fertilizer, the Argel in the phase of the continuous increasing prices of chemical fertilizers.. This experiment was laid out on spilt-split-plot experiment in Randomized Complete Block Design (RCBD) with four replications. Observations were taken on some agronomic traits (Plant height (m), Leaf area (LA), leaf Number (NL), Leaf Area Index (LAI) and Mean Seed Weight). The results revealed that the application of Argel and Nitrogen fertilizer have significantly increased the leaf Area ($F= 7.22, P < 0.001$), Plant Height ($F=2.68, P < 0.2001$), Leaf Number ($F= 3.90, P < 0.0024$), Leaf Area Index ($F= 3.83, P < 0.0026$) and Mean Seed Weight of both Serena and Opera cultivars respectively compared to the control. However, the different treatments of Argel and Nitrogen reflected variable degree of increase for the studied parameters. The study concludes that Argel is very promising, therefore a further study with different levels of Argel including other plant parameters is recommended.

Corresponding author: Abubaker H. M. Adam, Department of Crop Science, College of Agriculture, University of Bahri, Khartoum North-Sudan. Email: abubakerharoun@gmail.com

Keywords: Leaf Area Index, Treatment, Observation, Design, Parameters

Received: May 18, 2020 **Accepted:** Jun 13, 2020 **Published:** Jun 20, 2020

Editor: Raj Kishori, CSIR-Central Institute of Medicinal and Aromatic Plants, P.O. CIMAP, Lucknow, U. P, India.

Introduction

Sunflower (*Helianthus annuus* L.) is one of the most important and valuable oil crops in this world. It ranks the 4th oil seed plants, preceded by soybean, oil palm and rapeseed plant [1, 2]. Botanically, it is a native plant of North America. The plant belongs to order Asterales, family *Asteraceae* and genus Helianthus[3]. It is classified as annual or perennial plant. Some species can grow to a height of 120 in. The stem is unbranched in domesticated cultivars, but branched in the upper part in wild plants. The plant has erect stem with broadleaf. Leaves are dentate, petiolated. The lower leaves are opposite and ovate. The plants bear one head with bright yellow ray florets at the outside and yellow disc florets inside. Some ornamental cultivars have red-colored ray florets [4]. During the growth, sunflowers tilt during the day to face the sun, but stop once they begin blooming. This phenomenon enables the plant to utilize more sunlight in the process of photosynthesis, and it called heliotropism[5].

The seeds contain of excellent quality and high oil content (40-50%), high unsaturated fatty acid concentration, low linolenic acid content, and 30% digestible protein[6]. They have several uses, among these, human use; like cocking oil, snack food, beside *baking uses* (granola bars, multigrain breads). Sunflower seed meal *is used as feed for livestock* (green fodder and silage). Other uses like paints, adhesives lubricants, soap manufacture, plastics and detergents, biofuel production etc. However, few species have other economic importance such as medical source and ornamentals[7].

Sunflower has broad adaptation to different edaphoclimatic zones. It gained more importance because of its unique oil quality, photo-insensitivity, tolerant to both low and high temperatures, short duration of maturity, can be grown year around, and the possibility of incorporating the crop in different cropping patterns. Therefore it is grown over much broader geographic regions, in the arid and semi arid regions under optimum temperature ranging from 23 to 28 °C. [8] and it performs better under drought conditions compared to other field crops[9].

To obtain high yield potential, the crop requires a good crop husbandry in terms of adequate water, nutrient supply; weed control and pest/diseases management throughout the growing period [10].

The crop has a big, branched and extensive root system which enables to utilize nutrients with high efficiency compared with other field crops like Maize and Sorghum [11].

Sunflower is considered one of the promising oil crops in Sudan. It is well suited to Sudan environmental conditions. It is grown as winter crop under irrigated conditions, and as summer crop under rain-fed [12].

To attain maximum yield, the crop requires fertilizers. Synthetic fertilizers are widely used, with less attention to organic fertilizers. However, today more attention is paid to organic fertilizers as a remedy to cure the ills of the chemical fertilizers in the face of dramatic and substantially increase prices of the chemical fertilizers. However, it is reported that application of organic fertilizer in Sunflower production has increased both sunflower oil quality and yield attributes [13], therefore; it became necessary to develop a workable, compatible package of nutrient manage-ment through organic sources for various crops, capable of providing all the essential minerals to promote crop growth and development [13].

In Sudan; most if not all Sunflower growers use synthetic fertilizers in crop production for a long time. For the above quoted reason farmers began to look for alternative sources of fertilizers; among which a herb plant called Argel which had been traditionally in use in different parts of Sudan since.

Argel *(Solenostemma argel)* is a herb plant [14]; which is locally known as Hargal (Arabic). The plant has many uses; ranging from medicinal to fertilizer and pesticides. Nevertheless, tradition farmers in some parts of Sudan use Argel as pest replants, curing illness and sometimes as fertilizer. Despite the great importance; Argel is not given the necessary care as fertilizer except in the field of horticulture, specifically the palm date tree.

Sunflower yield differs according to cultivars, prevailed climate condition and adopted cultural practices. During the season 2015/2016 the world total production was about 39.19 million metric tons, with an average yield of 1.7 metric tons/ha obtained from an area of 23.06 million hectares [15], compared to the

domestic productivity of 222 kg/Fed [16]. It is clear that there is a gap between the local and world average yield, but, recently the yield improved due to the application of new technologies. However, the major producing countries are Ukraine, Russia, European Union, Argentina Turkey, United States, India and China, accounting for 70% of global production [14], while the major exporting countries are the Union of Soviet Socialist Republic (USSR), United States of America (USA), and Argentina are the biggest exporting countries [15].

According to Arab Organization for Agricultural Development, the other producing countries are Turkey, Pakistan, Egypt, Syria, Morocco and Iraq with the latest having the largest cultivated area of about 5,975,000 ha. producing 89,000 metric ton [17].

During the period from 1980's to 199's Sudan has witnessed a leap in Sunflower production, when Sunflower hybrid cultivars; the Hysun-33 and PAN-7351 were introduced from Australia and South Africa [18, 19], beside the release of two open pollinated varieties namely; Bolero and Rodio under the names Damazin-1 and Damazin-2, respectively[20]. The crop gained ground, and was grown in the central clay plain under large scale ran-fed farming, and limited areas in irrigated schemes. But its expansion was confronted with several production constraints[21].

It is reported that Sunflower was introduced to Gezira Research Station-Wad Medani -Sudan in 1932, then the research was extended to other research stations in 1960s. The commercial production of Sunflower began in late 1980's and the early 1990's following the introduction of hybrids cultivars [18,19]. It began in Blue Nile State El Damazin area, which considered as the highest potential for growing sunflower under mechanized rain-fed farming due the good amount of rainfall, and vast arable fertile cultivable land. This experience was pioneered by EL Sheik Mustafa El Amin Company. Then it expanded from Blue Nile to other rain-fed areas like Gedarif and El Renk [14]. The crop also grown under irrigation sector in ALRahad, Al Gezeria, Sennar and El Gash, Blue Nile and White Nile Pumps Irrigation Schemes. The highest yield (621 Kg/ fed.) was obtained during 2011/2012. Unfortunately, due to financial and political reasons, the productivity deteriorated and the area declined to 57000 fed.[14].

Moreover, in Sudan, the hybrid varieties such as Hysun 33 and Pioneer were reported to perform better than the open pollinated as far as yield concern. Therefore, hybrid cultivars were widely grown in Sudan due to seed availability in the market; representing 90% of the cultivating area by Sunflower[22]. It is reported that, there are many cultivars in the world; but they differ in their seed characteristics, oil content, plant height, and maturity date [23].

Materials and Methods

A trial was conducted during 2017/2018; at Agricultural Farm of the College of Agriculture-University of Bahri –AlKadaro- Sudan, in a heavy clay soil with pH ranges between 7.5 - 8 described as saline soil. Where the two Sunflower cultivars, the Serena and Opera (H-16-096\0306) were studied in split-split-plot experiment based on Randomized Complete Block Design (RCBD) with four replications. The two cultivars were considered as the main-plot treatments, while the four levels of Nitrogen (N0, N1, N2 and N3) as subplot treatments, and the four levels of Argel (A0, A1, A2, and A3) as sub-subplot treatments.

The rates of application of Argel were 0, 140, 240 and 340 Kg/fed., while the treatments of Nitrogen were 0, 25, 50 and 75 kg/fed. All cultural practices such as sowing date; frequent irrigation, thinning, and application of herbicide were timely carried out as recommended by the Research Centre in Sudan. Data pertaining agronomic traits like Leaf Area (LA), Plant Height (m), Leaf Number (LN), Leaf Area Index (LAI) and Mean Seed Weight were randomly collected. The said data were analyzed by Statistic 8 Software. The results were presented in the form of tables and figures. (Plate 1 and Plate 2)

Results and Discussion

All results of data analysis presented in tables (1-5), and figures (1-4); followed by discussion. Moreover, the results of statistic 8 software are found in the appendix. (Table 1, Figure 1)

The results of the data analysis demonstrated that the overall leaf Area of Serena and Opera cultivars (Table 1. And Figure. 1) has significantly increased when treated with Argel and Nitrogen (F=7.22, P<0.001). Both treatments N1 and A1 for Serena produced bigger Leaf Area (134.29 and 137.95)

Plate 1. First irrigation of Sunflower (Serena and Opera), Farm of the college of Agriculture, University of Bahri at Alkadaro - Sudan (2017/2018)

Plate 2. Sunflower (Serena and Opera) at flowering stage-Farm of the College of Agriculture, University of Bahri - Alkadaro-Sudan (2017/2018)

Table 1. Effect of Argel and Nitrogen on the Leaf Area of Serena and Opera Cultivars. AlKadaro Sudan (2017/2018)

Cultivar	**Serena**				**Mean**
Treatment	**R1**	**R2**	**R3**	**R4**	
N0	17.127	19.575	74.200	85.852	49.18
N1	50.860	129.925	148.975	206.950	134.17
N2	42.725	126.125	160.625	200.100	134.39
N3	26.425	94.050	136.200	179.325	108.98
A0	19.250	39.825	42.900	54.875	39.21
A1	27.000	109.550	170.625	244.625	137.95
A2	27.400	81.525	126.075	165.525	100.13
A3	20.825	68.225	125.457	216.200	107.67
Cultivar	**Opera**				**Mean**
Treatment	**R1**	**R2**	**R3**	**R4**	
N0	16.250	20.500	69.500	82.225	47.11
N1	32.080	105.280	180.340	191.470	127.29
N2	22.975	82.100	122.050	319.800	136.73
N3	28.500	90.525	162.600	83.975	91.4
A0	20.500	40.900	71.575	83.700	54.15
A1	26.250	94.025	133.150	220.695	118.53
A2	27.400	82.200	154.100	208.133	117.95
A3	19.845	84.900	119.733	75.250	74.932

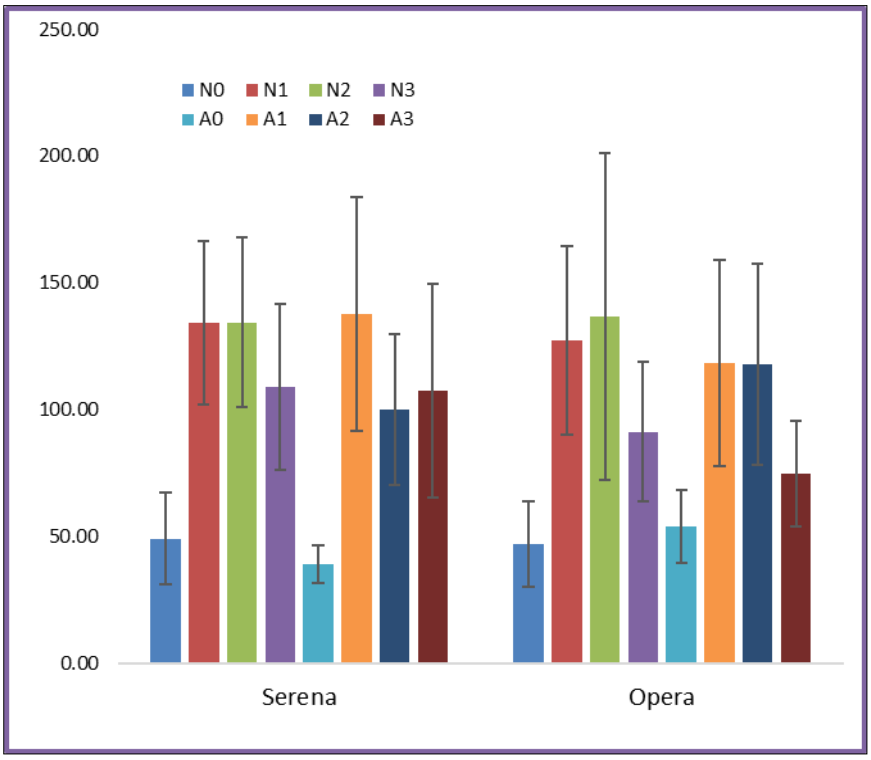

Figure 1. Effect of Argel and Nitrogen on Leaf Area (LA) of Serena and Opera

respectively compared with other treatments. For Opera, both N2, and A1 produced the biggest Leaf Area (136.27, 118.53) respectively compared with the control. Moreover, the result showed there is no significant difference in the leaf area of Serena and Opera cultivars due to application of either Argel or Nitrogen. Furthermore, the two cultivars "Serena and Opera" responded similarly (F=2.68, P<0.2001) to Argel and Nitrogen treatments. (Table 2, Figure 2)

Considering Table 2, and Figure.2, the results showed that the Plant Height of Serena and Opera cultivars was significantly influenced by application of Argel or Nitrogen as fertilizers (F= 4.28, P <0.0012). Moreover, the Nitrogen level N2 and Argel level A1 gave the highest Plant Height (53.88, 53.97 cm) for Serena compared to other treatments, while N1 and A2 gave the highest Plant Height (52.97, 54.19 cm) respectively for Opera compared with the other treatments. Furthermore, the result exhibited there is no significant difference in the plant height of Serena and Opera cultivars as a result of application of either Argel or Nitrogen. In addition, the plant height of the two the cultivars responded equally to Argel and Nitrogen applications (F=0.03, P < 0.877).

The results of analysis (Table 3, and Figure, 3) revealed that the Leaf Number of both Serena and Opera cultivars was significantly increased when treated with Argel and Nitrogen (F =3.90, P <0.0024). Moreover, the results displayed that N1 and A0 produced more number of leaf (29, 27) respectively for Serena, while N3 and A1, A2 produced more similar Leaf Number (23) for opera compared to the other treatments.

Furthermore, the result presented that there is no significant difference in the leaf number of Serena and Opera cultivars as a result of application of either Argel or Nitrogen. Additionally, the leaf number of Serena and Opera cultivars responded similarly to Argel and Nitrogen (F=7.02, P < 0.0770)

The results in Table 4 and Figure 4, present the Leaf Area Index of Serena and Opera cultivars was significantly enlarged due to application of Argel or Nitrogen as stimulants (F= 3.83, P< 0.0026). Moreover, the results displayed that N2 and A1 gave the highest Leaf Area Index (574.12, 591.85) respectively for Serena compared to the other treatments, while N3 and A1 produced the highest Leaf Area Index (544.06, 494.19) for Opera respectively compared with other treatments (Table 4, Figure 4). Furthermore, the result showed no significant difference in the leaf area index of Serena and Opera cultivars as a result of application of either Argel or Nitrogen. Furthermore, the leaf area index of the two cultivars responded in the same way to Argel and Nitrogen applications (F=0.88, P < 0.4166).

However, all results obtained in this study coincide with the results obtained by experiment conducted at Quoz Hindi area, Elgureir, Merawi Locality, Northern State, Sudan during 2004/2005 and 2005/2006**,** when Argel was applied to Palm date tress as dry fertilizer., this treatment has enhanced flowering and yield parameters of date palms and improved the physical characteristics of the fruits [23] *Tagelsir I. M. Idris,1 Asma M. A. Ibrahim,1 Elfatih M. Mahdi2 and Awad K.Taha* (2011): Influence of argel (Solenostemma argel Del. Hayne) soil applications on flowering and yield of date palm (Phoenix dactylifera L.). Agriculture and Biology Journal of North America ISSN Print: 2151-7517, ISSN Online: 2151-7525, doi:10.5251/ abjna.2011.2.3.538.542 © 2011, ScienceHuβ, http:// www.scihub.org/ABJNA [(30) 27]

Table 5 reviled that N2 (47.713) and A3 (56.847) produced highest Mean Seed Weight for Serena, while N3 (43.232) and A1 (57.474) produces the highest Mean Seed Weight for Opera.

It worth mentioning that, in Sudan, despite the technological advancement in the area of Sunflower crop production, yet there a big gap between the yields obtained by farmer 99 to 374 kg/fed. under rain-fed and 09 to 813 kg/fed under irrigation compared to Research plots 513 to 1062 kg/fed and 410 to 874 kg/fed under irrigation and rain-fed farming respectively. This low productivity is attributed to many factors; including organization set up, crop management, finance, marketing, pests/diseases, policy, environmental factors like erratic and fluctuating rainfall, Poor extension services, strategies and production plans[15].

Mamoun I. Dawelbeit (2012): Sunflower Production in the Sudan. Opportunities and Challenges. The First International Conference on Seeds Oil –Corinthia Hotel, Khartoum –Sudan, Nov.

Table 2. Effect of Argel and Nitrogen on Plant Height (cm.)of Serena and Opera – AlKadaro-Sudan (2017/201)

Cultivar	**Serena**				Mean
Treatment	**R1**	**R2**	**R3**	**R4**	
N0	24.250	27.750	30.200	34.825	29.25
N1	15.850	44.225	64.550	86.800	52.85
N2	14.625	35.250	71.775	93.875	53.88
N3	16.150	29.750	61.750	78.400	46.51
A0	18.900	24.250	28.125	35.150	26.60
A1	11.556	35.700	69.975	98.675	53.97
A2	10.875	22.725	54.500	96.800	46.22
A3	16.950	19.575	78.400	90.475	51.35
Cultivar	**Opera**				**Mean**
Treatment	**R1**	**R2**	**R3**	**R4**	
N0	13.175	29.750	32.575	39.225	29.43
N1	13.040	34.460	70.500	88.860	51.71
N2	18.725	34.400	71.225	84.550	52.22
N3	17.475	25.125	63.850	80.500	46.73
A0	14.950	29.000	33.550	43.375	30.21
A1	10.825	33.525	48.625	99.900	48.21
A2	13.500	24.125	78.250	100.900	54.19
A3	10.367	27.033	59.467	93.333	47.55

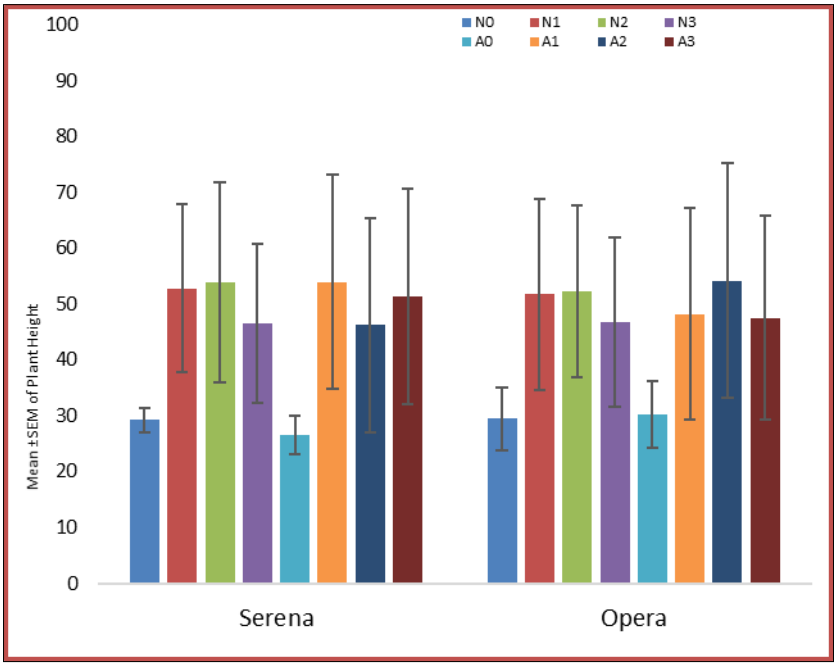

Figure 2. Effect of Argel and Nitrogen on Plant height (cm)

Table 3. Effect of Argel and Nitrogen on leaf Number ofSerena and Opera – AlKadaro-Sudan (2017/201)

	Serena				
Treatment	R1	R2	R3	R4	Mean
N0	13	25	27	30	23
N1	18	28	33	40	29
N2	12	24	27	31	23
N3	15	24	27	28	23
A0	16	27	29	38	27
A1	9	21	27	29	21
A2	10	19	26	31	21
A3	12	19	26	30	21
	Opera				
Treatment	R1	R2	R3	R4	Mean
N0	15	22	21	20	19
N1	13	20	27	30	22
N2	11	21	27	30	22
N3	14	21	27	30	23
A0	12	25	24	23	21
A1	13	23	26	30	23
A2	12	22	28	32	23
A3	10	21	26	27	21

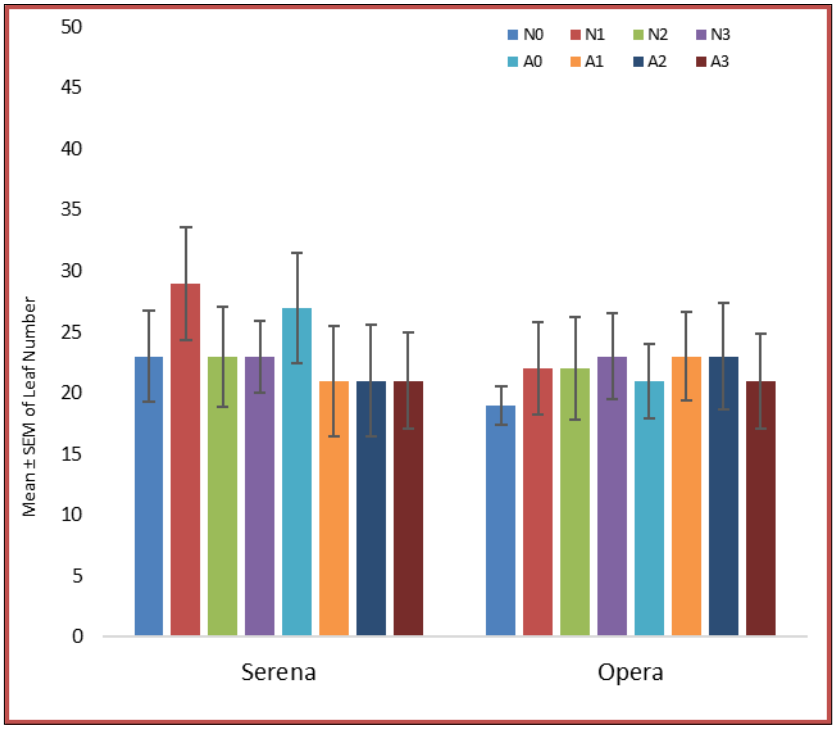

Figure 3. Effect of Argel and Nitrogen on leaf number of Serena and Opera

Table 4. Effect of Argel and Nitrogen on leaf Area Index of Serena and Opera – AlKadaro-Sudan (2017/201)

	Serena				
Treatment	R1	R2	R3	R4	Mean
N0	145.500	258.500	671.075	794.500	467.39
N1	125.893	376.070	586.928	912.928	500.45
N2	183.535	540.208	688.388	884.358	574.12
N3	111.100	402.930	584.000	768.643	474.16
A0	284.000	290.875	295.875	299.225	292.49
A1	117.748	504.708	825.283	919.695	591.85
A2	116.250	349.325	527.460	761.035	438.51
A3	90.748	302.573	617.500	918.250	482.26
	Opera				
Treatment	R1	R2	R3	R4	Mean
N0	48.325	82.250	118.750	129.575	94.72
N1	132.764	473.800	628.186	882.880	529.40
N2	85.285	352.175	522.960	817.040	444.36
N3	174.965	372.785	649.500	1302.993	544.06
A0	154.650	374.922	567.000	683.035	444.97
A1	105.215	324.500	498.573	1048.497	494.19
A2	88.605	347.892	560.750	948.892	486.53
A3	81.000	363.997	514.413	891.857	462.81

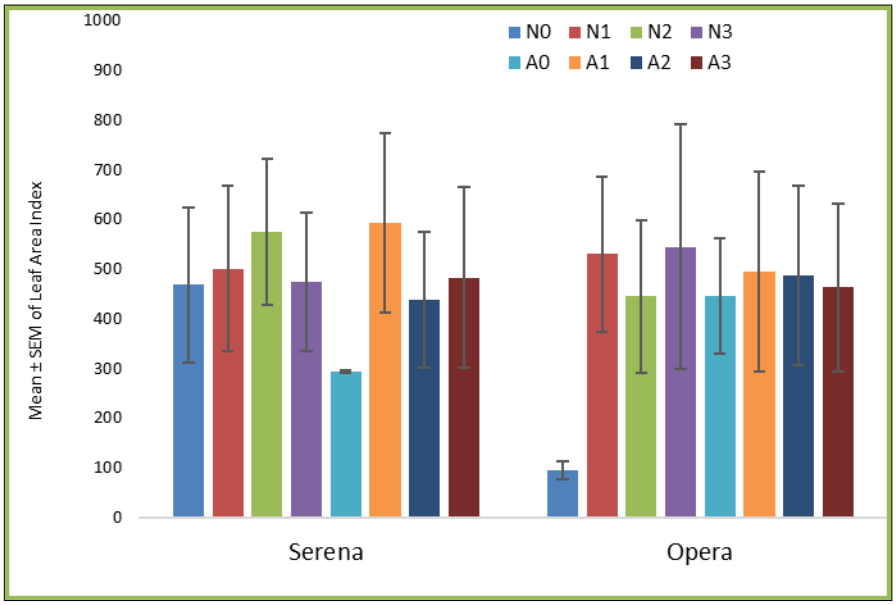

Figure 4. Effect of Argel and Nitrogen on leaf Area Index

Table 5. Effect of Argel and Nitrogen on seed weight of Serena and Opera- AlKadaro-Sudan (2017/201)

Serena	
Treatment	Mean Seed weight
N0	24.650
N1	24.880
N2	47.713
N3	30.978
A0	28.275
A1	51.240
A2	36.318
A3	56.847
Opera	
Treatment	Mean Seed weight
N0	13.100
N1	38.952
N2	31.467
N3	43.232
A0	48.265
A1	57.150
A2	41.747
A3	36.213

2012. (31)[28].

Conclusion and Recommendations

This study aimed at investigating the possible potentiality of Argel as an economic organic fertilizer that can play an important role to improve crop yield and save hard currency, in a word characterized by low crop yield, dynamic population expansion, increasing demand for food in the face of substantially; dramatic increases of prices of the synthetic fertilizer.

In the light of the above discussion, it is time to look for alternative sources for fertilizers, particularly the organic fertilizers. Therefore, this study was directed towards looking for easy, accessible, socially acceptable, economic sound and environmentally friend. In this regard, Argel, was studied. The results displayed that Argel is similar to nitrogen fertilizer has significantly increased all studied parameters of the two Sunflower cultivars,.

The study recommends for further study; to include all agronomic traits, yield, yield components, and oil content of different sunflower cultivars as well as other field crops.

APPENDIX

Statistix 8.0 12-Feb-20, 2:57:54 AM

ANOVA Table 1: Impact of Argel and Nitrogen on leaf area

Source	DF	SS	MS	F	P
REPLICATION (A)	3	167709	55903.0	2.68	0.2001
VARIETY (B)	1	433	432.6		
ERROR A*B	3	484	161.4		
FERTILIZER (C)	7	68870	9838.6	7.22	0.0000
B*C	7	4310	615.7	0.45	0.8635
ERROR A*B*C	42	57270	1363.6		
TOTAL	63	299075			

Grand Mean 98.616
CV(REPLICATION*VARIETY) 12.88
CV(REPLICATION*VARIETY*FERTILIZER) 37.44

Statistix 8.0 12-Feb-20, 2:57:54 AM

ANOVA Table 4: Impact of Argel and Nitrogen on plant height

Source	DF	SS	MS	F	P
REPLICATION (A)	3	337730.9	12577.0	0.03	0.8772
VARIETY (B)	1	0.3	0.3		
ERROR A*B	3	33.6	11.2		
FERTILIZER (C)	7	5894.7	842.1	4.28	0.0012
B*C	7	256.8	36.7	0.19	0.9867
ERROR A*B*C	42	8260.8	196.7		
TOTAL	63	52177.1			

Grand Mean45.013
CV(REPLICATION*VARIETY) 7.43
CV(REPLICATION*VARIETY*FERTILIZER) 31.16

Statistix 8.0 12-Feb-20, 2:57:54 AM

ANOVA Table 3: Impact of Argel and Nitrogen on leaf number

Source	DF	SS	MS	F	P
REPLICATION (A)	3	2657.61	885.938	7,02	0.0770
VARIETY (B)	1	72.25	72.250		
ERROR A*B	3	30.87	10.292		
FERTILIZER (C)	7	133.94	19.134	3.90	0.0024
B*C	7	170.75	24.393	4.97	0.0004
ERROR A*B*C	42	206.31	4.912		
TOTAL	63	3271.94			

Grand Mean 23.031
CV(REPLICATION*VARIETY) 13.93
CV(REPLICATION*VARIETY*FERTILIZER) 9.62

Statistix 8.0 12-Feb-20, 2:57:54 AM

ANOVA Table 4: Impact of Argel and Nitrogen on leaf Area Index

Source	DF	SS	MS	F	P
REPLICATION (A)	3	4035869	1345286	0.88	0.4166
VARIETY (B)	1	13429	13429		
ERROR A*B	3	45601	15200		
FERTILIZER (C)	7	481505	68786	3.83	0.0026
B*C	7	420762	60109	3.35	0.0063
ERROR A*B*C	42	753681	17945		
TOTAL	63	5750836			

Grand Mean 461.24

CV(REPLICATION*VARIETY) 26.67

CV(REPLICATION*VARIETY*FERTILIZER) 28.98

References

1. Rodriques, D., Romero-Garcia, J., Rodriguez-Garcia, R. and Angualo-Sanchez, J.L., (2002): Characterization of proteins from sunflower leaves and seeds: relationship of biomass and seed yield. In: Trends in New Crops and New Uses. Proc. AAIC Fifth National Symposium, Purdue Univ., USA: 143-149.
2. Ahmed, B., M. Sultana, J. Zaman, S.K. Paul, M.M. Rahman, M.R Islam, F. Majumdar. (2015): Effect of Sowing Dates on the Yield of Sunflower. Bangladesh Agron. J., 18 (1): 1-5.
3. Agricultural Research Service *(ARS),* United States Department of Agriculture *(USDA)* (2011): Helianthus*.* Germplasm Resources Information Network *(GRIN).*Retrieved 2011-02-22.
4. Heiser, C.B. (1981): The Sunflower. University of Oklahoma Press. 1981.
5. Sia Morhardt, Emil Morhardt (Without date): California Desert Flowers, University of California Press, pp. 29–32.
6. Mohamed, M.Y (2010): Development and Stability of Some Sudanese Sunflower Hybrids under Irrigated Conditions. HELIA, 33, Nr. 52, p.p. 135-144, (2010) UDC 633.854.78:631.526.325:631.67 DOI: 10.2298/ HEL1052135M.
7. Srivastava, Aishwarya, Verma Anisha (2014): Nutritional Composition of Sunflower Seeds Flour and Nutritive Value of Products Prepared by Incorporating Sunflower Seeds Flour. International Journal of Pharmaceutical Research & Allied Science. Volume 3, issue 3 (2014):45-49. ISSN 2277-3657.
8. Department of Agriculture, Forestry and Fisheries, Republic of South Africa, (2010): Sunflower Production Guideline.
9. C. de Castro, F. A. Oliveira, A. Oliveira Junior and N. P. Ramos (2014): Nutrition and fertilization of Sunflower in Brazilian Cerrado. In Sunflowers: growth and development, environmental influences and pests/diseases**.** ISBN: 978-1-63117-348-6 (eBook)- QK495.C74S87 2014- 583'.99--dc23.
10. Mohamed, M.Y. (2010): Oilseed Crops Research Center, Agricultural Research Corporation (ARC),P.O. Box 126, Wad Medani, Sudan. HELIA, **33**, Nr. 52, p.p. 135-144, (2010). DOI: 10.2298/HEL1052135M.
11. Seyed Abdolreza Kazemeini, Mohsen Edalat and Avat Shekoofa (2009): Interaction effects of deficit irrigation and row spacing on sunflower (*Helianthus annuus* L.) growth, seed yield and oil yield. African Journal of Agricultural Research Vol. 4 (11), pp. 1165-1170, November,2009http:// www.academicjournals.org/AJAR ISSN 1991-637X © 2009 Academic Journals.
12. Rafig Ahmadi and Nusart Jabeen (2009): Demonstration of growth improvement in Sunflower (Helianthus annus) by the use of organic fertilizers under saline conditions. Pak. J. Bot., 41 (3): 1373-1384, 2009.
13. Rasool, F. Hassan, B. Jahangir I.A. Ali, T. Mubarak, T. (2013): Nutritional Yield and Economic Responses of sunflower to integrated levels of Nitrogen, Sulphur and Farm Yard Manure*.* University of Agricultural Sciences and Technology of Kashmir, India. 191-121
14. El-Kamali, H.H., (1991): Botanical and chemical studies on Solenostemma argel (Del.) Hayne grown in Khartoum. MSc. Thesis, University of Khartoum, Khartoum, Sudan.
15. Mamoun I*.* Dawelbeit (2012): Sunflower Production in the Sudan. Opportunities and Challenges. The First International Conference on Seeds Oil –Corinthia Hotel, Khartoum –Sudan, Nov. 2012.
16. KhidirM.O. 1997. Oil seed plants in Sudan. Khartoum University press. (Arabic)
17. League of Arab States, (2000): Agricultural development.
18. United States Department of Agriculture (USDA) (2016).
19. El Ahamdi, A.B., (2003): A proposal for the release of three sunflower hybrids. Paper presented to the Variety Release Committee. Khartoum, Sudan (14).
20. Nour, A.M., Mohamed, M.Y., and Ahmed, O.M., (2005): A proposal for the release of new sunflower hybrids for rain-fed and irrigated conditions of the Sudan. A paper presented to the Variety Release

Committee. Khartoum, Sudan).

21. Adam NEM, Osman HG (1989): Performance of some open-pollinated sunflower varieties at the Blue Nile under rain and supplementary irrigation. Paper submitted to Variety Release Committee. Khartoum, Sudan.
22. Amin El Sir A. I.1, Abubaker A. Abdallah1, Adlan M. Ahmed1, Ezeldeen A. Banaga1 and Omima B. Haj (2017): Effects of sowing date on sunflower *(Helianthis annuus* L.) yield and yield components under rain-fed conditions in Blue Nile State, Sudan. Merit Research Journal of Agricultural Science and Soil Sciences (ISSN: 2350-2274) Vol. 5 (3) pp. 060-063, March, 2017 Available online http://meritresearchjournals.org/asss/ index.htmCopyright © 2017 Merit Research Journals.
23. Tagelsir I. M. Idris,1 Asma M. A. Ibrahim,1 Elfatih M. Mahdi2 and Awad K.Taha (2011): Influence of argel (Solenostemma argel Del. Hayne) soil applications on flowering and yield of date palm (Phoenix dactylifera L.). Agriculture and Biology Journal of North America. ISSN Print: 2151-7517, ISSN Online:2151-7525,doi:10.5251/ abjna.2011.2.3.538.542 © 2011, Science Huβ, http://www.scihub.org/ABJNA