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Effect of nitrogen level and time of application on growth, seed yield and oil content of Sunflower (*Helianthus annuus* L.), Gezira State, Sudan

Abdulluh A. A. Hammadi[1], Ahmed E. Daffalla[2] and Ibrahim E. Mohamed[2]

1. Faculty of Agriculture , University of Anbar, Bagdad, Iraq

2- Faculty of Agricultural Sciences, University of Gezira, Wad Madani, Sudan

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ABSTRACT

Nitrogen (N) is one of the major nutrients that enhances the metabolic processes that leads to increase in growth and yield of crops. However, the time of nitrogen application affects seed yield of sunflower and reduces nitrogen losses. The objective of the current study was to investigate the effects of nitrogen level and time of application on growth, seed yield and oil content (%) of sunflower. Field trials were carried out at the experimental farm of the Faculty of Agricultural Sciences, University of Gezira, Wad Medani, Sudan, during summer and winter seasons of 2017/18. Four nitrogen levels (0, 43, 86, 129 Kg N/ha)) and three times of nitrogen application, namely, at early + at budding, at early + at flowering and at budding + at flowering were used. (A randomized complete block design with three replicates was used). The sunflower cultivar Hysun-33 was used. Results indicated that nitrogen had significant effects on plant height, LAI, dry weights, number of seeds/plant, 1000 seed weight, empty seeds percentage (%), seed yield and oil content (%) in both seasons. Time of N application had significant effects on plant height, dry weights, number of seeds/plant and oil content (%) in both seasons and on 1000 seed weight and seed yield in summer season only. The highest seed yield (2852.4kg/ha) was obtained when 86 kg N /ha was applied at early + at flowering in summer season and (2373.6 kg/ha) when 129 kg/ha was applied at budding + at flowering in winter season. However, zero nitrogen application obtained significantly highest oil content in summer season, while 129kg N/ ha at budding +at flowering in winter season. It is recommended to apply 86 or 129 kg N /ha at early +at flowering or at budding + flowering in summer and winter seasons, respectively. However, to achieve the highest oil content, nitrogen application is not advisable under Gezira conditions,

KEYWORDS:

INTRODUCTION

Sunflower (*Helianthus annuus* L.) is a member of the Asteraceae, large family of the flowering plants with sixty seven species in the genus. Sunflower probably originated in South West United States of America and Mexico (Heiser, 1979). It is considered to be a rich oilseed crop, ranking as a third after soybean and peanut (Thavaprakash *et al*., 2002).The average oil content of the seed 40-50% (entire fruit) and 50-60% (kernel only).

The major sunflower producing countries, in the world are Russia, Argentina, China, United States of America, France, Spain, Romania, South Africa, and Canada. Among the Arab countries, Egypt, Syria, Iraq, Sudan, and Palestine are the main producer in 2004 (AOAD, 2005).

Sunflower grow and is adapted to a wide range of soils but perform best on good soils suitable for wheat and maize production (Radanielson *et al*., 2012). Sunflower is mainly grown as an oilseed crop in most parts the world.

Nitrogen is one of the major nutrients that enhance the metabolic processes that leads to increase in vegetative, reproductive growth and yield of the crop. Increased nitrogen supply stimulates plant growth and productivity (Joel and Gamon, 1997). Applied N not taken up by the crop or immobilized in the soil by microorganisms is lost by volatilization, denitrification, leaching and runoff, and can cause serious environmental problems (Canfield et al., 2010).

In the Sudan, Daffalla (2013) found that progressively higher increment of nitrogen increased the growth parameters as plant height , fresh weight , dry weight, LAI and all yield components and seed yield up to 129 N kg/ha. Also, in the oilseed crops are important and ranks second after the cereal crops regarding the area production. Sesame (*Sesamum indicm* L.), groundnut (*Arachis hypogaea* L.) and cotton seed (*Gossypium hirsutum* L.), are most important edible oilseed of the Sudan but not long ago great emphasis has been given to sunflower as a new edible oil for the Sudanese people (Obeid, 2001). Therefore, the main objectives of this study, is to determine the effect of nitrogen and its time of application on sunflower growth attributes, yield , yield components and oil content (%) in Gezira state, Sudan.

MATERIALS AND METHODS

Field experiment was conducted at the experimental farm of the Faculty of Agricultural Sciences, University of Gezira, Wad Medani, Sudan (latitude 14^{o} 06 N and longitude 33^{o} 38E and altitude 400 masl), during summer and winter (2017 / 2018). The soil belongs to Selemi series and it is characterized by semi- arid climate with an average precipitation of 250-350 mm during the rainy season from late June to late September, Dark brown, deep cracking clay soil, with very low permeability when moist, pH of 8.3, low in organic matter (0.5%), nitrogen (0.03%) and available phosphorus 6 mg/kg soil.(Soil Survey Staff,1999).

Treatments consist of four N– levels: 0, 43, 86 and 129 Kg N/ha, and three times of nitrogen as urea (46%) were placed beside the plant at two equal doses at early + at budding stage, at early + at flowering and at budding + at flowering . The cultivar Hysun33 was used. The treatments were arranged in a randomized complete block design (RCBD) with three replicates. Plot size was 3.5 X 4 m (14 m2). Weeds were manually removed at third and sixth week after sowing.

The experimental site was disc ploughed, harrowed, leveled and ridged 80 cm apart. Seeds of sunflower were sown by hand in holes 20 cm apart by means of a marker. Three seeds per hole were placed on 15th of July and November respectively. The plants were thinned to one plant/hole two weeks later. Irrigation was applied at 12 days interval in both seasons.

Plant samples were taken at regular intervals during the two seasons to monitor the effect of the treatments. Five plants were sampled, at random from the second inner rows. Data collected include : Plant height (cm), number of leaves/plant, LAI, dry weight of whole plant, seed yield (Kg /ha)and yield components, Determination of oil content (%). The collected data was statistically analyzed using the standard statistical procedures, for each season separately. Duncan's multiple range test (DMRT) was used for means separation of the measured characters.

RESULTS AND DISCUSSION

Plant height.

Effect of nitrogen levels, time of nitrogen application and their interaction on sunflower plant height in summer and winter seasons is presented in Table 1, Zero nitrogen application significantly ($P \leq 05$) produced shorter plants than other nitrogen levels in both seasons. The interaction of nitrogen levels and time of nitrogen application had significant effect ($P \leq 0.05$)on plant height in both seasons. The tallest plants (177 cm and 164 cm) were recorded when the nitrogen applied at early + at flowering coupled with 43kg N/ha in summer and winter seasons, respectively (table 1). These findings were in agreement with those of Kandil *et al*., (2006) who reported that application of nitrogen at different rates (72, 120, 168 kg N|ha) increased plant height than zero kg N/ha treatment. However, Khanzada *et al*. (2016) Also, reported that the timing of nitrogen application had significant effect on all growth and yield parameters such as plant height, head diameter, 1000 seed weight and seed yield.

Leaf Area Index (LAI)

Table 2 showed the effect of nitrogen levels, time of nitrogen application and their interaction on leaf area index (LAI) in summer and winter seasons. . N applied at all nitrogen levels, significantly ($P \leq 005$) produced larger LAI than zero nitrogen treatment, with no significant differences between them.. The interaction of nitrogen levels and time of nitrogen application had significant ($P \leq 0.05$) effect on LAI in both seasons. The nitrogen 43kg N/ ha applied at early + at budding or at budding + flowering obtained larger LAI (3.5 and 4.2) in summer and winter seasons, respectively. These findings were in line with those of Tenebe *et al*. (1996), in Nigeria, who reported that leaf area index of sunflower increased significantly with increasing the rate of nitrogen from 0 to 100 Kg/ha. Graham and Varco (2017) in USA, who reported that the timing of N had no significant effects on growth parameters ,including LA!.

Table 1. Effect of nitrogen levels, time of nitrogen application and their interaction on plant height (cm) of sunflower grown at the experimental farm of the Faculty of Agricultural Sciences, University of Gezira, Wad Medani, Sudan in summer and winter seasons (2017/18).

Treatments	Summer season				
	Nitrogen levels (Kg/ha)				
	0	**43**	**86**	**129**	**Mean**
Early + At budding	105.6b	168.9 a	162.2 a	176.2a	153.2
At early + At flowering	106.1b	177.2 a	175.6 a	169.0 a	157.0
At budding + At flowering	106.6b	176.1 a	171.4 a	172.0 a	156.0
Mean	106.1 B	174 A	169.4 A	172.4 A	155.6
SE±			5.90		
C.V%			6.57		
	Winter season				
Early + At budding	138.0d	153.5bc	151.5bc	149.6c	148.2B
At early + At flowering	137.6d	164.0a	151.0bc	164.0a	154.2A
At budding + At flowering	138.3d	162.3a	155.2b	153.0b	152.2AB
Mean	138D	159.8A	152.7C	155.6A	151.5
SE±			1.30		
C.V%			1.49		

Means followed by the same letter (s) are not significantly different at 0.05 level of probability according to Duncan's multiple range test (DMRT)

Table 2. Effect of nitrogen levels, time of nitrogen application and their interaction on leaf area index (LAI) of sunflower grown at the experimental farm of the Faculty of Agricultural Sciences, University of Gezira, Wad Medani, Sudan in summer and winter seasons (2017/18).

Treatments	Summer season				
	Nitrogen levels (Kg/ha)				
	0	**43**	**86**	**129**	**Mean**
At Early + At budding	2.5de	3.5a	2.7bcde	3.1abc	3.0
At early +At flowering	2.6cde	3.3ab	3.5a	3.4ab	3.2
At budding + At flowering	2.3e	3.4a	3.0abcd	3.0b	2.9
Mean	2.1B	3.4A	3.1 A	3.2 A	3.0
SE±			0.18		
C.V%			10.34		
	Winter season				
Early + At budding	2.6c	3.7ab	3.7a	3.8b	3.5
early + At flowering	2.8c	3.4b	3.4a	3.9b	3.4
At budding + At flowering	2.6c	4.2a	3.5a	3.4b	3.4
Mean	2.0.B	3.8A	3.5A	3.4A	3.4
SE±			0.15		
C.V%			7.84		

Means followed by the same letter(s) are not significantly different from each other according to Duncan's multiple range test (DMRT).

Dry weight of plant (g)

The effect of nitrogen levels on dry weight / plant is presented in table 3. Nitrogen applied at different rates had significant effects on dry weight in both seasons. The interaction effects of nitrogen and time of nitrogen application weight was significant ($P \leq 0.05$) in both seasons . The plants received 43kg N/ ha at early+ at budding produced the heaviest dry weight (146.6 g) and (88..2 g) in summer and winter season respectively. These results were in agreement with those of Daffalla, (2013) who found that increment of nitrogen increased the growth parameters as plant height , fresh weight , dry weight and LAI up to 129 N kg/ha. Khanzada *et al*. (2016) reported that the timing of nitrogen application had significant effect on all growth and yield parameters such as plant height, head diameter, 1000 seed weight and seed yield.

Number of seeds /head:

The nitrogen resulted in significant increase in seeds/head in both seasons (Table 4). The highest number of seeds/head was obtained by 43kg and129kg N/ ha in summer and winter seasons, respectively. The effect of time of nitrogen application on number of seed/ head was significant in both seasons. The

nitrogen applied at early + at budding produced significantly (P ≤005) greater number of seeds / plant than the other two treatments in summer season. The interaction of nitrogen X time of application on number of seeds/head was significant (P≤0.05) in summer season only. Application at early + at budding or at budding + at flowering coupled with 129kg N/ ha treatments produced significantly (P≤0.05) higher number of seeds /head in summer season and winter season respectively. than the others combinations. These results were in line with those of Daffalla, *et al*. (2013), in Sudan, who found that nitrogen level of 86 and 129 Kg/ha were superior to other levels (0 and 43 Kg/ha) with respect to all characters including the number of seeds/head..

Head diameter (cm):

The effect of nitrogen levels, time of nitrogen application and their interaction on head diameter is presented in Table 5. The nitrogen levels had no real impact on head diameter in both seasons. But, plants received nitrogen had bigger heads than that plants not treated. The time of nitrogen application had no significant (P≤0.05) effect on head diameter in both seasons .The interaction of nitrogen X time of nitrogen application had significant effect on head diameter in the summer only.. The bigger head diameter (16.5 and 13.7 cm) was obtained by the application of 43kg N/ ha and 86kg N/ ha given at early + at flowering and at early + at budding in both seasons. These results were in line with those of Nasim et al., (2012) who stated that the response of N fertilizer with various rates on head diameter was higher with increasing nitrogen and disagree with Babiker (1987/88), in Sudan, who reported that N rates had no significant effect on head diameter..

1000 - seed weight (g):

Nitrogen applied at the three rates, significantly (P≤0.05) had heavier 1000 – seed weight compared to that received zero nitrogen in both seasons.. Moreover, 86 kg N/ ha and 43kg N/ha produced significantly (P≤0.05) greater 1000 - seeds weight (55.9 and 46.4 g) in summer and winter seasons, respectively. The effect of time of nitrogen application on 1000- seed weight was significantly in summer season only. As the nitrogen applied at early + at flowering produced significantly (P ≤05) heavier 1000-seed weight (54.0 g) than the other two treatments. The interaction of nitrogen levels X time of nitrogen application had significant (P≤ 0.05) effect on 1000-seed weight in summer season only. The nitrogen levels applied at early + at flowering coupled with 86kg N/ ha obtained had the heaviest seed weight (65.4 g) (Table 6). These results were in line with Osman, et al. (2002/03), in Sudan, who reported that there were no significant differences due to application of N levels from 0N up to 86.63Kg/ha, irrespective of the source, and in line with Daffalla, *et al.* (2013), in Sudan, who found that nitrogen level of 86 and 129 Kg/ha were superior to other levels (0 and 43 Kg/ha) with respect to all characters, including 1000 seed weight.

Table 3. Effect of nitrogen levels, time of nitrogen application and their interaction on dry weight (g) of sunflower grown at the experimental farm of the Faculty of Agricultural Sciences , Gezira University, Wad Medani, Sudan in summer and winter seasons (2017).

Treatments	**Summer Season**				
	Nitrogen levels (Kg/ha)				
	0kg	43kg	86kg	129kg	**Mean**
At Early + At budding	39.2 d	146.6a	1132.8 ab	116.7bc	108.8A
At early + At flowering	38.9 d	131.6 ab	119.7bc	116.2bc	101.6 B
At budding + At flowering	38.5c	131.5 a	120.1 b	117.3b	101.7 B
Mean	38.9B	136.6 A	124.2A	116.7A	104.1
SE±				5.45	
C.V%		9.27			

	Winter Season				
At Early + At budding	59.8cd	88.4a	50.0d	88.2a	71.6
At early + At flowering	59.9cd	65.4bc	73.3ba	60.6cd	64.8
: At budding + At lowering	60.0bc	68.0bc	68ab	78.3ab	68.5
Mean	59.9c	73.8A	63.7AB	75.9A	68.3
SE±		4.61			
C.V%		11.70			

Means followed by the same letter (s) are not significantly different at 0.05 level probability according to Duncan's Multiple Range Test (DMRT).

Table 4. Effect of nitrogen levels, time of nitrogen application and their interaction on number of seed per head of sunflower grown at the experimental farm of the Faculty of Agricultural Sciences , Gezira University, Wad Medani, Sudan in summer and winter seasons (2017).

Treatments	**Summer Season**				
	Nitrogen levels)Kg/ha)				
	0	**43**	**86**	**129**	**Mean**
At Early + At budding	664.7c	987.3ab	1028.0a	1071.7a	937..9 A
At early + At flowering	655.7c	980.3ab	869.0b	954.7ab	864.9 B
At budding + At flowering	663.3c	944.3ab	853.3b	842.7b	825.9 B
Mean	661.2B	970.7A	916.8A	956.0 A	876.3
SE±		9.81			
C.V%		49.63			
	Winter Season				
At Early + At budding	539.3	785.7	740.0	753.7	704.7A
At early + At flowering	540.3	700.3	598.3	719.0	639.5B
At budding + At flowering	564.0	730.0	729.0	843.7	716.0A
Mean	547.9C	738.7AB	689.1B	772.1A	686.9
SE±		9.81			
C.V%		49.63			

Means followed by the same letter (s) are not significantly different at 0.05 level probability according to Duncan's Multiple Range Test (DMRT).

Table 5. Effect of nitrogen levels, time of nitrogen application and their interaction on head diameter (cm) of sunflower grown at the experimental farm of the Faculty of Agricultural Sciences , Gezira University, Wad Medani, Sudan in summer and winter seasons (2017).

Treatments	**Summer Season**				
	Nitrogen levels (Kg/ha)				
	0	**43**	**86**	**129**	**Mean**
At early + At budding	13.23 d	14.4 bc	13.0 e	15.4abc	14.0
At early + At flowering	13.0 e	16.5 a	15.6 ab	15.7 ab	15.2
At budding + At flowering	13.0 e	14.7 bc	14.3 cd	14.7 bc	14.1
Mean	13.1C	15.2 A	14.3 A	15.2 A	14.5
SE±		0.37			
C.V%		4.51			
	Winter Season				
At early + At budding	10.8	13.3	13.7	11.3	12.3
At early + At flowering	10.3	12.5	11.2	11.6	11.4
At budding + At flowering	11.46	12.5	11.9	11.5	12.1
Mean	10.9	12.8	12.2	11.5	1.9/3
SE±		8.68			
C.V%		0.60			

Means followed by the same letter (s) are not significantly different at 0.05 level probability according to Duncan's Multiple Range Test (DMRT).

Table 6. Effect of nitrogen levels, time of nitrogen application and their interaction on 1000_ seed weight (g) of sunflower grown at the experimental farm of the Faculty of Agricultural Sciences , Gezira University, Wad Medani, Sudan in summer and winter seasons (2017).

Treatments	Summer Season				
	Nitrogen levels (Kg/ha)				
	0	**43**	**86**	**129**	**Mean**
Early + At budding	39.0 e	47.3 d	53.8 bcd	49.4 bcd	47.4B
At early + At flowering	39.0 e	55.5 be	65.4 a	56.0 b	54.0A
At budding + At flowering	39.3 e	50.1 bce	48.5 cd	51.5 bcd	47.4 B
Mean	39.1 C	51.0 B	55.9A	52.3AB	49.6
SE±	2.13				
C.V%	7.47				
	Winter Season				
Early + At budding	37.0	46.6	43.6	40.3	41.9
At early + At flowering	36.3	49.3	40.3	43.0	42.3
At budding + At flowering	36.3	39.3	46.7	46.7	45.0
Mean	36.9C	46.4A	43.6B	43.3B	43.0
SE±	2.13				
C.V%	7.47				

Means followed by the same letter (s) are not significantly different at 0.05 level probability according to Duncan's Multiple Range Test (DMRT).

Unfilled seeds percentage (%):

Nitrogen levels had significant effect on unfilled seed in summer season only. The plants of zero nitrogen produced significantly (P≤0.05) higher percentage of unfilled seeds/head in both seasons. The time of nitrogen application had no significant effect on the percentage of unfilled seeds/head in both seasons. The interaction of nitrogen levels and time of nitrogen application was significant (P≥ 0.05) in winter season only. The plants of the three times of application X 0N produced significantly (P≥0.05)higher percentage of unfilled seeds/head than other combinations (Table 7). Our results were harmony with those of f Osman, et al. (2002/03), in Sudan, who reported that there was significant in empty seed percentage decrease due to application of N levels up to 86.63Kg/ha. Contrary to that, Singh and Singh (1977), in India, showed that nitrogen application increased number of empty seeds/head

Seed yield (kg/ha)

Table 8 shows that the overall mean of seed yields was higher (2226 kg/ ha) in summer than in winter season (1812 kg/ ha). Nitrogen applied at the rate 43, 86, and 129kg N/ ha resulted in a significantly (P≤0.05) higher seed yield than the control in both seasons These findings agreed with those of Elsahooki (1994) who reported that seed yield increased with an increasing amount of nitrogen rate. Zuberiski and Zimmerman (1974), in Australia, who stated that seed yield of sunflower increased by 27% over 0N when 112 kg N/ha was applied. They attributed that to the increase in number of seeds/m2, 1000- seed weight, head diameter and decreasing percentage of unfilled seeds/head. The highest seed yield (2553 and

2167.7kg/ ha) was obtained by 866 and 43kg N/ ha in the summer and winter season, respectively. The increase in yield was mainly attributed to the increase in number of seeds/plant and 1000 – seed weight. Application of nitrogen at early + at budding or at early + at flowering produced significantly ($P \leq 0.05$) higher seed yield than that applied at budding + at flowering in summer season. It was higher by 15 % and 17%, respectively, in summer season. However, no significant differences were found between the three times of application in winter season. (Table 8) The results of the study have further been confirmed by

Table 7. Effect of nitrogen levels, time of nitrogen application and their interaction on unfilled seeds percentage (%) of sunflower grown at the Experimental Farm of the Faculty of Agricultural Sciences , Gezira University, Wad Medani, Sudan in summer and winter seasons (2017).

Treatments	**Summer Season**				
	Nitrogen levels (Kg/ha)				
	0	**43**	**86**	**129**	**Mean**
Early + At budding	16.5	8.1	9.0	10.9	11.1
At early + At flowering	16.0	9.6	8.0	9.63	10.8
At budding + At flowering	16.2	9.1	9.8	10.6	11.4
Mean	16.2 a	8.9 c	8.9 c	10.4 b	11.1
SE±		0.59			
C.V%		9.5			
	Winter Season				
Early + At budding	10.7a	7.0d	8.5bc	8.1bcd	8.3
At early + At flowering	10.9a	6.1d	11.0a	9.8ab	9.5
budding + At flowering	9.9ab	7.1cd	7.3cd	7.5cd	8.5
Mean	10.5	6.4	8.9	8.5	8.6
		0.64			
		12.92			

Means followed by the same letter (s) were not significantly different at 0.05 level probability according to Duncan's Multiple Range Test (DMRT).

Table 8. Effect of nitrogen levels, time of nitrogen application and their interaction on seed yield (kg) of sunflower grown at the Experimental farm of the Faculty of Agricultural Sciences, University of Gezira, Wad Medani, Sudan in summer and winter seasons (2017/18).

Treatments	Summer season				
	Nitrogen levels (Kg/ha)				
	0	43	86	129	Mean
Early + At budding	1486.2d	2331.2abc	2743.4ab	2731.0ab	2322.8 A
At early + At flowering	1276.5d	2737.ab	2852.4a	2648.3abc	2378.8A
At budding +At flowering	1300.0d	2374.7abc	2063.4c	2168.5bc	1976.3B
Mean	1354.3C	2480.9B	2553.1A	2515.9A	2226.0
SE±			191.38		
C.V%			14.89		
	Winter season				
Early + At budding	1245.3cd	2113.8ab	2132.3ab	2135.9ab	1879.2
At early + At flowering	1210.7cd	2146.0ab	1569.4bcd	1771.4abc	1767.5
budding + At flowering	1077.8d	2243.2ab	1729.2abcd	2373.6a	1790.5
Mean	1178.0B	2167.7A	1810.3A	2093.6 A	1812.4
SE±			204.04		
C.V%			19.5		

Means followed by the same letter(s) was not significantly different at 0.05 level probability according to Duncan's Multiple Range Test (DMRT).

Nel and Loubser (2000), in South Africa, who reported that the timing of nitrogen application at sowing or at beginning of flowering had no effect on seed yield , seed quality characteristics and oil content The interaction of nitrogen and time of nitrogen application had significant ($P \geq 0.05$) effect on seed yield in both seasons. The nitrogen rate at dose of 86kg N/ ha at early + at flowering obtained significantly ($P \leq 0.05$) higher seed yield (2852.4) in summer season, whereas, applying 129kg N/ ha at budding + at flowering (2373.6 kg/ha) in winter season (Table 8).

Oil content (%)

All nitrogen levels had a significant effect on oil content (%) in both seasons . The highest oil content(49.6%) was recorded by the control treatment (0N) in summer season, while it was obtained when 129kg N/ha was applied (46.3%), in winter season

The oil content (%) was negatively associated with the time of nitrogen application in summer season. It decreased gradually at budding + at flowering to the plants cross –out nitrogen application produced significantly (P ≤ 05) higher oil content (49.4%) compared to the other two treatments. In winter season, applying N at budding + at flowering produced significantly (P≤0.05) higher oil content (%) compared to the other two treatments (At early +at budding or At budding + at flowering)The interaction of nitrogen and time of nitrogen application was significant (P ≤ 05) in both seasons . The plants received 0N at early + at flowering treatment or 0N at early + at budding produced significantly (P ≤ 05) higher oil content (51 and 49%), respectively in summer season. While, the low and high doses of nitrogen (zero and 129kg N/ ha) produced significantly (P≤0.05) higher oil content (%) when applied at budding + at flowering in winter season.(Table 9). These results agree with Naveed and Malik (2005), in Pakistan, who reported that higher sunflower oil content was obtained (44.79%) by increasing rates of N up to 150 kg/ha. Also, agreed with Osman and wed. (2010) who observed that increasing the rate of nitrogen levels reduced the oil content. The oil variation between the two seasons may be due to variation in environment, specially, temperature during summer and winter seasons. Graham and Varco (2017) in USA, who reported that the timing of N applied had no significant effect on grain yield, N uptake or oil yield..

Table 9. Effect of nitrogen levels, time of nitrogen application and their interaction on oil content (%) of sunflower grown at the experimental farm of the Faculty of Agricultural Sciences, university of Gezira, Wad Medani, Sudan in summer and winter seasons (2017/18).

Treatments	**Summer Season**				
	Nitrogen levels (Kg/ha)				
	0	**43**	**86**	**129**	**Mean**
At Early + At budding	49.8ab	49.0b	48.9b	50.0ab	49.4a
At early + At flowering	51.0a	46.3d	47.1cd	45.7 d	47.5b
At budding + At flowering	48.5bc	43.e	49.0ab	46.6cd	46.8b
Mean	49.6A	46.1C	48.3AB	47.4BC	47.7
SD			1.30		
	Winter season				
Early + At budding	45.3bc	45.7bc	41.8e	46.4ab	44.8ab
At early + At flowering	43.9cde	42.2de	45.3b	43.7cde	43.8b
At budding + At flowering	46.7ab	43.5cde	43.3cde	48.7a	45.6a
Mean	45.3AB	43.8BC	43.5C	46.3A	44.73
SD			2.07		

Means followed by the same letter(s) was not significantly different at 0.05 level probability according to Duncan's Multiple Range Test (DMRT).

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