

RESEARCH PAPER

Effect of different fertilizers and sowing date on growth, yield, and yield components of Sesame (*Sesame indicum L.*)

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ABSTRACT:

A factorial experiment was conducted on the summer season of 2019 at two locations Grdarasha experimental field (Latitude: 36° 4' N and Longitude: 44° 2' E- elevation 415 meters above Sea level), College of Agricultural Engineering sciences, Salahaddin University, Erbil Iraqi Kurdistan Region and Erbil Research Director field /Ainkawa (Latitude : 36° 14' N, 43° 59' E, 420 meters above sea level) using factorial experiment arranged in randomized design to investigate the effect of Four different formula of fertilizers (NPK; NPK+ Magnesium and Micro elements (Zn, Fe); Magnesium and Micro elements (Zn, Fe); No fertilizer were added considered as control) on growth, yield and yield component of sesame crop (*Sesame indicum L.*) under three sowing dates (20th of May, 4th of June and 19th of June). Results showed a significant rapid increase of branches number per plant, number of capsules per plant, and number of seeds per capsule, 1000 seeds weight (g), biological yield, grain and straw yield (t ha⁻¹) when treated with (NPK plus Magnesium and Micro elements) fertilizer compared to the control treatment at the first sowing date. An interaction between first sowing date and second Fertilization formula recorded highest value compared to the others treatments.

KEY WORDS: fertilization, sowing date, Micronutrients, Sesame yield

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1. INTRODUCTION:

Sesame (*Sesamum indicum L.*) is belonging to Pedaliaceae family is regarded as one of the most important edible oil seed crops in the world because of its high oil content (45-60%), protein 20-25% and carbohydrates 15% and vitamins. Sesame seeds are involved in sweet Manufacturing, pastries and sprinklers in addition to use of its pallet in animal diets (Jan *et al.*, 2014). Sesame considered one of the oldest crops in the world, science it cultivated for over 5000 years in all tropical and subtropical countries in Asia and Africa for its high-nutrition and edible seeds (Bisht *et al.*, 1998). So, it called the Queen of oil seeds due to its virtue excellent quality and utility, (Hafiz and El-Bramawy, 2012).

From physiological view sesame is a short-day plant, drought- tolerant crop, requires adequate soil moisture for establishment and vegetative growth and development, (Olowe, 2007). The optimum temperature for growth range between 27–35 °C, temperatures below 20 °C inhibit germination and retard seedling's growth, (Bennett, 1995)

Fertilizers changed Sesame crop productivity and its industry has grown significantly, it was (Erman *et al.*, 2011) reported that macronutrients such as nitrogen (N), phosphorus (P) and potassium (K) are essential and important for plant growth and yield, (Erman *et al.*, 2011). (N P K) fertilizers have been extensively studied and proven to significantly intensify sesame yield in the tropics,

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while growth and yield of sesame were greatly influenced by the application of N fertilizer (Zenawi and Mizan, 2019). Micronutrients are essential for plant life and have an important role in crop development, so lack of any one of the micronutrients in the soil will cause limited growth. The beneficial effect of micronutrients may be attributed to its role in activating different enzymes in plants, the efficient utilization of applied nutrients improves and increases growth and yield components (Tiwari *et al.*, 1996) and (Shanker *et al.*, 1999). In the Iraq Kurdistan Region, sesame crop is cultivated and usually fertilized with nitrogen and phosphorus fertilizers, and no one gave attention to fertilize sesame with macro and micronutrients. There for this was done to investigate the effect of different fertilizers nitrogen, phosphorus, potassium, magnesium and two microelements (Iron and Zinc) with three different sowing dates on sesame growth, yield, and yield component in two different locations.

2. Materials and Methods

2.1. Studied Sites description: The experiment was conducted in two locations, Grdarasha field (Latitude: 36° 4' N and Longitude: 44° 2' E-elevation 415 Meters above sea level) The experimental researches field College of Agriculture Engineering Sciences, Salahaddin University Erbil Kurdistan Region of Iraq, and Erbil Research Directorial field /Ainkawa (Latitude: 36° 14' N, 43° 59' E, 420 meters above sea level), during 2019 agricultural season. Some soil physiochemical properties for both locations were determined in table (1).

2.2. Experimental design: A factorial experiment was carried out in a randomized complete block design (RCBD) arrangement with three replications. The studied factors were sowing dates (20th of May, 4th of June, and 19th of June in 2019) and four different mineral fertilizers: Only (NPK); NPK + Magnesium and Microelements (Iron - Zinc); Magnesium and micro elements (Iron -Zinc); and no fertilization regarded as

(control). The plot size was 9 m² (3 x 3 m) keeping one meter between plots. Each plot consisted of 4 rows having 60 cm row-to-row distance, and 30 cm within plants.

2.3. Agronomical practices: Experimental plots were prepared by dries ploughing the land twice vertically one on the other, the land leveling was done, then rows were established by chisel plow, after that, it was hand seeded with sesame (Somar) genotype on (20th of May, 4th of June, and 19th of June in 2019) with rate (60 kg ha⁻¹). Seeds were sown at 1-2 cm depth. The irrigation process was done by drip irrigation, other practices were done out when needed.

2.4. Fertilization type: Nitrogen formula urea 46%N was applied in two doses (80 kg N ha⁻¹) the first dose at sowing time and the second dose was applied 45 days after sowing (DAS). Phosphorus formula triple super phosphate 46% p₂O₅ was applied at the rate of (80 kg ha⁻¹) with sowing seeds. While liquid potassium (5L ha⁻¹) with concentration 50% k₂O was added in two doses (40 and 65) days after sowing (DAS). liquid Magnesium (Mgso₄) Dose was (5L ha⁻¹) was applied thrice (40, 65and 90) days after sowing. Iron (Feso₄) (3.5L. ha⁻¹) thrice (40,65and 90) days after sowing. Zinc (Znso₄) (2L ha⁻¹) three times (40,65 and 90) days after sowing. liquid fertilizer sprayed with 16L capacity knapsack sprayer after calibration to ensure the rate of 2000L ha⁻¹.

2.5. Recorded Data - recorded parameters in this study could be categorized to:

2.5.1. Vegetative growth characteristics

Plant height (cm) calculated from the soil surface to the top of the plant, the number of branches per plant recorded the number of branches in one plant.

2.5.2. Yield and yield components

Number of capsules per plant, number of seed in a capsule per plant, weights of 1000-grains (g), biological yield t ha⁻¹, economical yield t ha⁻¹, straw yield t ha⁻¹ and harvest index (HI%) were recorded after harvesting (Jahan *et al.*, 2019).

Biological yield = grain yield + straw yield -----1

Harvest index % = $\frac{\text{Grain yield}}{\text{biological yield}} * 100$ (Dobermann, 2007)-----2

2.6. Statistical analysis: All recorded data were subjected to standard analysis of variance and means were compared using Duncan Multiple Range Test (DMRT) at 5% of probability using SPSS computer analysis version 22 according to (Bah, 2001)

3. Results & Discussion

3.1. The effect different mineral fertilization and sowing date on some growth and yield characteristics of (*Sesame indicum* L.) at Grdarasha and Ankawa locations.

3.1.1-Plant height:

Table (4 and 5) shows the effect types of fertilizers on plant height was significant, science (NPK + Magnesium and Micro elements) treatment recorded maximum average mean values of plant high (143.01 and 111.89) cm respectively in both locations Grdarasha and Ainkawa. While minimum average mean values recorded under control plots in both locations were (126.28 and 102.89) cm respectively. (Asl, 2017) reported that nitrogen and phosphorus application may increase plant height, also these results with those found by (Jadav *et al.*, 2010) and (Mahdi, 2014). Nitrogen promotes healthy growth in plants, vice versa deficiency of nitrogen decreased plant height, also low phosphorus concentration causes plant dwarfing. Zinc plays an important role in growth, hormone production and internode elongation, because it has a key role of many enzymes and proteins activation. Iron has an important role in the activation of meristematic cells and division hence elongation inter nodes (Alloway, 2008).

Combination NPK, Magnesium and Micro elements increased plant high compared to control plots. Plant height increased significantly at second sowing date compared to first and third sowing dates since registries the tallest height average mean values (138.96 and 116.75) cm in both locations respectively, while last sowing date recorded lowest plant height (128.24 and 98.25) cm in both locations respectively. These results are similar to what had been reported by (Al-Solagh, 2007). These variations in the results between sowing dates may be due to the environmental conditions that prevailed after sowing date, that were appropriate for the division and elongation of stem cells that may provide

nutrients for effective plant growth areas in the plant (meristematic cells). An interaction between fertilization and sowing dates exhibited significant effects on plant height, where maximum value recorded with fertilization (NPK + Magnesium and Micro elements (Iron-Zinc) at second sowing date in both locations with values (149.90 and 121.00) cm, while minimum values recorded in control plots with last sowing date (122.67 and 95.00) cm at both locations.

3.1.2-Number of branches plant⁻¹

The Results in tables (4 and 5) shows in Grdarasha, sowing dates significantly influenced branches per plant in which first sowing date recorded maximum Average mean value (3.20 branches plant⁻¹), while minimum value was (1.58 branches plant⁻¹) registered in last sowing date. Similar results have been reported by (Mahdi *et al.*, 2007). these results are going with those reported by. (Al-Solagh, 2007). The results regarding interaction between fertilization and sowing date significant effects appeared with (NPK) fertilizers in first sowing date, which recorded maximum value (3.86 branches plant⁻¹) while minimum value recorded in Magnesium and Micro elements plots when seeds were sown on last sowing date (1.27 branches plant⁻¹)

3.1.3-Number of capsules plant⁻¹:

Data in tables (6 and 7) revealed that fertilization with (NPK + Magnesium and Micro- elements) significantly enhanced capsule number per plant since the highest average mean values were (100.42 capsules Plant⁻¹ and 72. 56capsules plant⁻¹) in Grdarasha and Ainkawa locations. Whereas minimum Average mean values were (78.71 capsules plant⁻¹ and 56.78 capsules plant⁻¹) recorded in control plots for both locations Grdarasha and Ainkawa respectively. According to (Jan *et al.*, 2014; Ibrahim *et al.*, 2016; Mahdi, 2014 and Al-Maliky, 2015) number of capsules per plant were influenced by nitrogen, phosphorous and potassium fertilizer levels.

The role of potassium may enhance biological processes inside plants, increasing enzymatic activity and exchange of nutrients between cells. Nitrogen has a role in increasing the vegetative growth and thus increasing the process of photosynthesis. The lack of Fe means lack chlorophyll that decreases photosynthesis and unable of food production this led to decreases of capsule numbers in plant especially at flowering

stage. Zinc decreases photosynthesis rate and reduces the rate of plant components production, rather than the magnesium have a key role in chlorophyll chemical structure. Early sowing date on the 20th of may recorded higher capsule number with average mean values (110.28 capsules plant⁻¹ and 70.67 capsules plant⁻¹) in both locations respectively. While the lower average mean number of capsules per plant was obtained in last sowing dates (67.39 capsules plant⁻¹ and 62.76 capsules plant⁻¹) in both locations respectively Grdarasha and Ainkawa. These results are in agreement with (Al-Solagh, 2007). The reason for that may be due to the early sowing date of crop which had efficiency (photoperiod, temperature and humidity) For plant growth and development especially during the seed capsule formation which was positively reflected by photosynthesis rate.

Combination effect of between fertilization with (NPK + Magnesium and Microelements) and sowing date (first sowing date) recorded higher number of capsules with (129.44 capsules plant⁻¹ and 80.00 capsules plant⁻¹) in both locations. When NPK fertilizers in combination with last sowing date obtained minimum number of capsules per plant which was (62.10 capsules plant⁻¹) in Grdarasha location, while in Ainkawa the minimum value recorded by NPK combined with first sowing date was (55.00 capsules plant⁻¹).

3.1.4-Number seeds per capsule:

The significant effect of fertilizers registered maximum mean number of seeds per capsule were observed in (NPK+ Magnesium and Microelements) treatment plots (73.35 and 72.74 seeds capsule⁻¹) for both locations respectively (table 8 and 9), while minimum average mean values were recorded in control plots (59.36 and 61.11 seeds capsules. plant⁻¹) respectively in both locations Grdarasha and Ainkawa. These results are in line with (Buriro *et al.*, 2015) and (Mahdi, 2014). These may refer to leaf production, high nitrogen use, higher leaves efficiency for seed assimilates (Malik *et al.*, 2003). Activating many enzymes that increases the efficiency of the carbon metabolism processes (kobraee and Rasekhi, 2011). The highest average mean number of seeds per capsule was produced in early sowing (71.81 and 70.67 seeds. Capsule⁻¹) and lowest number of seed capsule per plant were obtained in late sowing date (64.86 and 62.76 seeds capsule⁻¹)

respectively in both locations Grdarasha and Ainkawa, the results reported with (Fadil, 2015). The declined seeds number in capsules at the last sowing dates may be attributed to the short period of growth compared to other sowing dates and the low temperature at the time of seed formation and filling, which negatively affected the photosynthesis process and its efficiency in preparing the emerging seeds with its requirements for growth and thus causes to a large number of seeds. Relying on interaction effect between fertilization and sowing date for these characters showed by (NPK + Magnesium and Microelements) treatment in first sowing dates which recorded maximum value (77.48 and 81.22) seeds capsule⁻¹ in both locations Grdarasha and Ainkawa. Meanwhile the minimum values were observed by control with last sowing date plots which reached (57.00 and 60.00) seeds capsule⁻¹ Grdarasha and Ainkawa.

3.1.5- 1000-thousand seeds weight (g):

(NPK+ Magnesium and Microelements) application caused significant effects on thousand seeds weight (table 10 and 11) when recorded maximum average mean values (3.67 and 3.56) g in both locations Grdarasha and Ainkawa respectively. However, the control plots recorded the lowest average mean values were (3.37 and 3.34) g respectively in both locations. The present results are also in line with those reported by (Akhtar *et al.*, 2015)

the effect of nitrogen and phosphorus on Sesame crop. These results are in accordance with those have been reported by (Shingabr *et al.*, 2019; (Al-Maliky, 2015; Seervi *et al.*, 2018 and Sarkar *et al.*, 2007) reported that phosphorus encourages photosynthesis rate and the number of metabolites synthesized by plants. The role of potassium in elevating enzyme activity, especially the enzymes that induce compounds to synthesize with high molecular weights such as carbohydrates, sugars and starch, as well as have an important role in transfer and movement of carbohydrates from their places of formation to storage.

Depending on the effect of Zn and Fe on thousand seeds weight of sesame crop. It was found that an increasing in added Fe led to increase the accumulation of storage food in seeds, thus an increase their average mean weight, including starch. tables (10 and 11) indicated on to the significant effects of Fe and Zn on the weight of thousand seeds. Early sowing date recorded

highest value for the average mean of thousand seeds weight in both stations showed up (3.58 and 3.53) g in both locations respectively Grdarasha and Ainkawa. While lowest value in both locations shows up (3.41 g) in the third sowing date. These results are closely related to the findings of (Al-Solagh, 2007). The optimum sowing date has a great role in providing suitable conditions for effective photosynthesis, which means giving a suitable chance for better growth and thus better-accumulating nutrients, which is directly reflected in the rate of seed filling and weight. Data in tables (10 and 11) indicated that interaction between fertilization and sowing date recorded in (NPK+ Magnesium and Micro elements) in first sowing date, when the highest value reached (3.73 and 3.63) g while the lowest value recorded by control treatment in last sowing data reached (3.30 and 3.30) g in both locations respectively Grdarasha and Ainkawa.

3.1.6. Straw yield per plant (t ha⁻¹)

The straw yield of sesame was also influenced significantly by different mineral fertilizers table (12 and 13). The highest data of average mean values were registered with (NPK + Magnesium and Microelements) which reach (4.15 and 3.55) t ha⁻¹ in both locations Grdarasha and Ainkawa. While the lowest values were recorded at control plots (3.77 and 3.09) t ha⁻¹ for both places Grdarasha and Ainkawa. This result was in line with (Jahan *et al.*, 2019) when they studied the effect of phosphorus on straw yield and (Bijarnia *et al.*, 2019) when investigated the effect of nitrogen and potassium on crop. Sowing date caused significant influences on straw yield of Sesame, the highest average mean values of straw yield were (4.79 and 3.54) t ha⁻¹ obtained from the first sowing date in both locations respectively. While, the lowest values were (3.55 and 3.18) t ha⁻¹ recorded from last sowing date in both locations respectively. This result is in line with results was obtained by (Al-Solagh, 2007). The reason may be due to the long growth period or to the increase in the number of plant branches, and thus to the prolonged period of exposure to sunlight, that elevated synthesis materials which increases the dry weight of the dry plant. The combination effects between fertilization and sowing, at Gardarasha locations maximum value recorded at treatment (NPK + Magnesium and Microelements in first sowing date) was (5.09) t

ha⁻¹, while minimum value recorded at Magnesium and Microelements in third sowing date which was (3.51) t ha⁻¹. While, at Ainkawa maximum value which was recorded at plot treatment (NPK + Magnesium and Microelements in second sowing date) was reached (3.62t ha⁻¹). As usual minimum value recorded at control plots in last sowing date reached (2.56t ha⁻¹).

3.1.7-Grain yield per plant (t ha⁻¹):

Data regarding grain yield are shown in table (14 and 15) which indicated to the significant effect of fertilization on this trait. The highest average mean values were (2.40 and 2.07) t ha⁻¹ recorded with (NPK +Magnesium and Microelements) contrary to control that recorded lowest value (2.10 and 1.58)t ha⁻¹in both locations respectively Grdarasha and Ainkawa. These results were consistent with (Hadif, 2012; Haruna *et al.*, 2012; Amare *et al.*, 2019 and Thakur *et al.*, 1998). Greater average mean of grain yield was recorded by planting sesame on the 20th of May (2.40 and 2.16) t ha⁻¹ in both locations respectively Grdarasha and Ainkawa. However, second sowing date takes the same letter a in both locations. While lowest value of average mean of grain yield recorded on 19th of June reached (2.07 and 1.68) t ha⁻¹in both locations respectively Grdarasha and Ainkawa. Similar results were studied by (Fadil, 2015). It appears from data presented in table (14 and15) that the interaction effects between first sowing date and second formula of fertilization recorded highest value reached (2.55 and 2.59) t ha⁻¹ in both locations respectively Grdarasha and Ainkawa. While lowest values were recorded by control plots in last sowing date (1.98 and 1.53) t ha⁻¹ in both locations respectively Grdarasha and Ainkawa. These findings were similar to results obtained by (Hafiz and El-Bramawy, 2012) when studied the interaction between phosphorus and potassium Sesame (*Sesame indicum* L.).

3.1.8-Biological yield (t ha⁻¹)

Biological yield significantly responded to mineral fertilizers (NPK+ Magnesium and Micro elements) application which recorded highest average mean values (6.55and 5.62) t ha⁻¹ in both locations Grdarasha and Ainkawa respectively. Control plots recorded lowest data (5.87and 4.67) t ha⁻¹ in both locations respectively table (16 and 17). Early sowing date significantly improved biological yield; the highest average mean values of biological yield was recorded when the crop

was sown on 20th of May (7.19 and 5.59) t ha⁻¹ in both locations respectively. Contrast to that 19th of June sowing date recorded lowest biological yield reached (5.62 t ha⁻¹ and 4.86 t ha⁻¹) in both locations respectively. These results are opposite what has been reported by (Hakeem *et al.*, 2017). The combined impact of fertilization and sowing date were significantly affected on biological field at interaction between (NPK +Magnesium and Microelements) when interact with first sowing date, since the plants obtained maximum values (7.64 and 6.09) t ha⁻¹ in both locations respectively Grdarasha and Ainkawa. While their Minimum values of biological yield were recorded at control plot in last sowing date reached (5.4 and 4.9) t ha⁻¹ in both locations respectively Grdarasha and Ainkawa.

3.1.9-Harvest index%

Table (18) shows the significant effect of fertilization types on the harvest index at Ainkawa which (Akhtar *et al.*, 2015) average mean value was (0.37%) that recorded with (NPK +Magnesium and Microelements) fertilization, while lowest value was recorded at control plots (0.34%) however micro elements plot take same letter. These results are in close conformity with the findings with (Bijarnia *et al.*, 2019; Heidari *et al.*, 2011; Seervi *et al.*, 2018). Significant

differences were found for the average mean value for the sowing dates in case of its effect on harvest index. Under Grdarasha environment second sowing date gained maximum value (0.39%) while minimum value was registered with first sowing date (0.33%). At Ainkawa location maximum average mean value recorded with first sowing date (0.38%) while minimum value recorded at second sowing date (0.32%). Significant different were found in Ainkawa, when higher value was recorded the interaction effect between (NPK +Magnesium and Microelements) plots with first sowing date (0.43%) while minimum value obtained at control in second sowing date (0.32%).

4. Conclusions

Types of fertilizer and sowing date are important factors that enhances vegetative growth, yield and yield components of sesame in both studied locations, best fertilization type was combination between (NPK +Magnesium and Microelements) and best sowing date was first sowing date for both locations.

Table (1): Some physical and chemical properties of the soil used in the Ainkawa and Grdarasha experiment

#	Locations	EC (dSm ⁻¹)	pH	N %	P (ppm)	K (ppm)	O.M %	Classification USDA			
								Clay%	Silt%	Sand%	Texture
1	Ainkawa.	0.3	7.9	0.09	7.86	180	1.0	38	43	19	Silty clay loam
2	Grdarasha.	0.3	7.3	0.14	9.7	300	1.5	48.4	43.3	8.3	Silty clay

The Soil properties were analyzed in Agriculture Research Centre - Ainkawa /Erbil.

Table (2): effects type of fertilizer and sowing date on plant high of *Sesame indicum* L. (Grdarasha).

FSD	F1(NPK)	F2(NPK+ (Mg+ Microelements)	F3 (Mg+ Micro elements)	F4(control)	Mean
1 st SD	129.83ab	145.30ab	143.43ab	125.67ab	136.06ab
2 nd SD	135.12ab	149.90a	140.33ab	130.50ab	138.96a
3 rd SD	125.53ab	133.83ab	130.93bc	122.67b	128.24b
Mean	130.16bc	143.01a	138.23ab	126.28c	134.42

Note: Means with the same symbols in one column are not significantly different from each other at alpha = 0.05 based on multiple range test of Duncan

Table (3): effects type of fertilizer and sowing date on plant high of *Sesame indicum* L. (Ainkawa)

FSD	F1(NPK)	F2 (NPK+ Mg+Microelem ents)	F3 (Mg+ Micro elements)	F4(control)	Mean
1 st SD	107.67cde	112.67abc	110.00bcd	105.00cdef	108.83b
2 nd SD	118.00ab	121.00a	119.33a	108.67cd	116.75a
3 rd SD	97.00fg	102.00defg	99.00efg	95.00g	98.25c
Mean	107.55B	111.89a	109.44ab	102.89c	107.94

Note: Means with the same symbols in one column are not significantly different from each other at alpha = 0.05 based on multiple range test of Duncan

Table (4): effects type of fertilizer and sowing date on number of branches of *Sesame indicum* L. (Grdarasha).

FSD	F1(NPK)	F2(NPK+ (Mg+ Microelements)	F3 (Mg+ Micro elements)	F4(control)	Mean
1 st SD	3.86a	3.28ab	3.33ab	2.33abc	3.20a
2 nd SD	2.33abc	2.34abc	2.50abc	1.90bc	2.27b
3 rd SD	1.70bc	2.00bc	1.27c	1.35c	1.58c
Mean	2.63a	2.54a	2.37a	1.86a	2.35

Note: Means with the same symbols in one column are not significantly different from each other at alpha = 0.05 based on multiple range test of Duncan

Table (5): effects type of fertilizer and sowing date on number of branches of *Sesame indicum* L. (Ainkawa).

FSD	F1(NPK)	F2 (NPK+ (Mg+ Microelements)	F3(Mg+ Micro elements)	F4(control)	Mean
1 st SD	1.50a	1.67a	1.30a	1.33a	1.45a
2 nd SD	1.30a	1.50a	1.10a	1.11a	1.25a
3 rd SD	1.20a	1.27a	1.00a	1.00a	1.12a
Mean	1.33a	1.48a	1.13a	1.15a	1.27

Note: Means with the same symbols in one column are not significantly different from each other at alpha = 0.05 based on multiple range test of Duncan

Table (6): effects type of fertilizer and sowing date on number of capsules per plant of *Sesame indicum* L. (Grdarasha).

FSD	F1(NPK)	F2(NPK+ (Mg+ Microelements)	F3 (Mg+ Micro elements)	F4(control)	Mean
1 st SD	96.39cd	129.44a	120.17ab	95.13cd	110.28a
2 nd SD	82.34de	104.67bc	101.73c	74.00ef	90.69b
3 rd SD	62.10f	67.16ef	73.30ef	67.00ef	67.39c
Mean	80.28b	100.42a	98.40a	78.71b	89.45

Note: Means with the same symbols in one column are not significantly different from each other at alpha = 0.05 based on multiple range test of Duncan.

Table (7): effects type of fertilizer and sowing date on number of capsules per plant of *Sesame indicum* L. (Ainkawa).

FSD	F1(NPK)	F2 (NPK+ Mg+ Microelements)	F3 (Mg+ Micro elements)	F4(control)	Mean
1 st SD	74.00ab	80.00a	73.67abc	55.00g	70.67a
2 nd SD	66.67cde	70.00bcd	64.00def	58.00fg	64.67b
3 rd SD	66.00de	67.67cde	60.04efg	57.33fg	62.76b
Mean	68.89b	72.56a	65.90ab	56.78c	66.03

Note: Means with the same symbols in one column are not significantly different from each other at alpha = 0.05 based on multiple range test of Duncan

Table (8): effects type of fertilizer and sowing date on number seed of capsules per plant of *Sesame indicum* L. (Grdarasha).

FSD	F1(NPK)	F2 NPK+ (Mg+ Microelements)	F3 (Mg+ Micro elements)	F4(control)	Mean
1 st SD	72.72ab	77.48a	76.00a	61.03bc	71.81a
2 nd SD	69.08abc	72.78ab	70.00abc	60.06bc	67.98ab
3 rd SD	65.83abc	69.78abc	66.83abc	57.00c	64.86b
Mean	69.21a	73.35a	70.94a	59.36b	68.21

Note: Means with the same symbols in one column are not significantly different from each other at alpha = 0.05 based on multiple range test of Duncan

Table (9): effects type of fertilizer and sowing date on number seed of capsules per plant of *Sesame indicum* L. (Ainkawa).

FSD	F1(NPK)	F2 NPK+ (Mg+ Microelements)	F3 (Mg+ Micro elements)	F4(control)	Mean
1 st SD	69.67bcd	81.22a	71.17b	62.33cde	70.67a
2 nd SD	67.67bcd	70.00bc	69.00bcd	61.00cd	64.67b
3 rd SD	65.00bcd	67.00bcd	66.00bcd	60.00d	62.76b
Mean	67.44b	72.74a	68.72ab	61.11c	66.03

Note: Means with the same symbols in one column are not significantly different from each other at alpha = 0.05 based on multiple range test of Duncan

Table (10): effects type of fertilizer and sowing date on 1000-thousand seeds weight of *Sesame indicum* L. (Grdarasha).

FSD	F1(NPK)	F2 NPK+ (Mg+ Microelements)	F3 (Mg+ Micro elements)	F4(control)	Mean
1 st SD	3.57ab	3.73a	3.53abc	3.47bc	3.58a
2 nd SD	3.47bc	3.73a	3.43bc	3.33bc	3.49ab
3 rd SD	3.43bc	3.53abc	3.37bc	3.30c	3.41b
Mean	3.49b	3.67a	3.44bc	3.37c	3.49

Note: Means with the same symbols in one column are not significantly different from each other at alpha = 0.05 based on multiple range test of Duncan

Table (11): effects type of fertilizer and sowing date on 1000-thousand seeds weight of *Sesame indicum* L. (Ainkawa).

FSD	F1(NPK)	F2 (NPK+ (Mg+ Microelements)	F3 (Mg+ Micro elements)	F4(control)	Mean
1 st SD	3.57ab	3.63a	3.53ab	3.40ab	3.53a
2 nd SD	3.50ab	3.53ab	3.50ab	3.33ab	3.47ab
3 rd SD	3.44ab	3.50ab	3.40ab	3.30b	3.41b
Mean	3.50a	3.56a	3.48a	3.34b	3.47

Note: Means with the same symbols in one column are not significantly different from each other at alpha = 0.05 based on multiple range test of Duncan.

Table (12): effects type of fertilizer and sowing date on straw yield of *Sesame indicum* L. (Grdarasha).

FSD	F1(NPK)	F2 (NPK+ (Mg+ Microelements)	F3 (Mg+ Micro elements)	F4(control)	Mean
1 st SD	4.81ab	5.09a	4.81ab	4.44abc	4.79a
2 nd SD	3.63c	3.71ab	3.6c	3.43c	3.59b
3 rd SD	3.61c	3.64abc	3.51c	3.44c	3.55b
Mean	4.02a	4.15a	3.97a	3.77a	3.97

Note: Means with the same symbols in one column are not significantly different from each other at alpha = 0.05 based on multiple range test of Duncan

Table (13): effects of fertilization type and sowing date on straw yield of *Sesame indicum* L. (Ainkawa).

FSD	F1(NPK)	F2 NPK+ (Mg+ Microelements)	F3 Mg+ Micro elements	F4(control)	Mean
1 st SD	3.46abcd	3.50abcd	3.45abcd	3.33cd	3.43b
2 nd SD	3.61ab	3.62a	3.53abc	3.38abcd	3.54a
3 rd SD	3.24d	3.52abc	3.37bcd	2.56e	3.18c
Mean	3.45a	3.55a	3.45a	3.09b	3.38

Note: Means with the same symbols in one column are not significantly different from each other at alpha = 0.05 based on multiple range test of Duncan

Table (14): effects type of fertilizer and sowing date on grain yield of *Sesame indicum* L. (Grdarasha).

FSD	F1(NPK)	F2 NPK+ (Mg+ Microelements)	F3 Mg+ Micro elements	F4(control)	Mean
1 st SD	2.40ab	2.55a	2.44ab	2.22ab	2.40a
2 nd SD	2.38ab	2.50a	2.44ab	2.11ab	2.36a
3 rd SD	2.13ab	2.16ab	2b	1.98b	2.07b
Mean	2.30ab	2.40a	2.29ab	2.10b	2.27

Note: Means with the same symbols in one column are not significantly different from each other at alpha = 0.05 based on multiple range test of Duncan.

Table (15): effects type of fertilizer and Sowing date on grain yield of *Sesame indicum* L. (Ainkawa).

FSD	F1(NPK)	F2 (NPK+ (Mg+ Microelements)	F3(Mg+ Micro elements)	F4(control)	Mean
1 st SD	2.38b	2.59a	2.01c	1.66def	2.16a
2 nd SD	1.8d	1.83cd	1.73d	1.55ef	1.73b
3 rd SD	1.74def	1.79d	1.66def	1.53f	1.68b
Mean	1.97b	2.07a	1.80c	1.58d	1.85

Note: Means with the same symbols in one column are not significantly different from each other at alpha = 0.05 based on multiple range test of Duncan

Table (16): effects type of fertilizer and sowing date on biological yield of *Sesame indicum* L. (Ainkawa)

FSD	F1(NPK)	F2(NPK+ (Mg+ Microelements)	F3 (Mg+ Micro elements)	F4(control)	Mean
1 st SD	7.21a	7.64a	7.25a	6.66ab	7.19a
2 nd SD	6.01bc	6.21ab	6.04bc	5.54bc	5.95b
3 rd SD	5.74bc	5.8bc	5.51c	5.42c	5.62c
Mean	6.32ab	6.55a	6.26ab	5.87b	6.25

Note: Means with the same symbols in one column are not significantly different from each other at alpha = 0.05 based on multiple range test of Duncan

Table (17): effects type of fertilizer and sowing date on biological yield of *Sesame indicum* L. (Ainkawa)

FSD	F1(NPK)	F2(NPK+ (Mg+ Microelements)	F3 (Mg+ Micro elements)	F4(control)	Mean
1 st SD	5.84a	6.09a	5.46b	4.99de	5.59a
2 nd SD	5.41b	5.45b	5.26bcd	4.93e	5.27b
3 rd SD	4.98de	5.31bc	5.03cde	4.09f	4.86c
Mean	5.42b	5.62a	5.25c	4.67d	5.24

Note: Means with the same symbols in one column are not significantly different from each other at alpha = 0.05 based on multiple range test of Duncan.

Table (18): effects type of fertilizer and sowing date on harvest index of *Sesame indicum* L. (Grdarasha)

FSD	F1(NPK)	F2(NPK+ (Mg+ Microelements)	F3 (Mg+ Micro elements)	F4(control)	Mean
1 st SD	0.33%a	0.33%a	0.34%a	0.33%a	0.33%b
2 nd SD	0.39%a	0.38%a	0.40%a	0.38%a	0.39%a
3 rd SD	0.37%a	0.375%a	0.36%a	0.36%a	0.37%a
Mean	0.36%a	0.36%a	0.37%a	0.36%a	0.36%

Note: Means with the same symbols in one column are not significantly different from each other at alpha = 0.05 based on multiple range test of Duncan

Table (19): effects type of fertilizer and sowing date on harvest index of *Sesame indicum* L. (Ainkawa)

FSD	F1 (NPK)	F1 (NPK+ Mg+ Microelements)	F3 (Mg+ Micro elements)	F4 (control)	Mean
1 st SD	.41%ab	.43%a	.37%c	.33d	.38%a
2 nd SD	.33%d	.33%d	.33%d	.32%d	.33%c
3 rd SD	.35%cd	.34%d	.33%d	.38%bc	.35%b
Mean	0.36%a	0.37%a	0.34%b	0.34%b	0.35%

Note: Means with the same symbols in one column are not significantly different from each other at alpha = 0.05 based on multiple range test of Duncan.

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