Amelioration Productivity of Sandy Soil by using Amino Acids, Sulphur and Micronutrients for Sesame Production

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Abstract: A field experiment was carried out at Ismailia Agricultural Research Station, Ismailia Governorate, Egypt for two successive summer seasons 2008 and 2009 using sesame (Giza 32) to study the effect of elemental sulphur as soil application, amino acids and micronutrients (Fe, Zn, Mn) as foliar spray and their interactions by concentration (A_0) zero and (A_1) 2 g/l, for amino acids, micronutrients Fe, Zn and Mn were added as mixture at rates of zero (T_0) & 450, 225, 225 µg g^{-1} (T_1) and 900, 450, 450 µg g^{-1} (T_2). While elemental sulphur was added at the rates of zero (S_0) & 0.5 Mg S/fed (S_1) and 1.0 Mg S/fed (S_2), on sesame yield, its components and seed quality. Data indicated that, plant height (cm) significantly affected by all applied treatments. The tallest plant height (213.3 cm) achieved upon treating by A_1 + 1.0 Mg S/fed + 900, 450, 450 µg g^{-1} Fe, Zn, Mn by rate of increases 48.0% over control. Data also show that there were significantly increases in the whole plant weight with increasing application of sulphur as soil application and micronutrients as foliar spray. The highest plant weight were achieved upon treating by A_1 + 1.0 Mg S/fed + 900, 450, 450 µg g^{-1} (Fe, Zn, Mn) by rate of increases 50.04% over control. A significantly increase in the seed sesame yields, the highest seed yields were achieved upon treating by A_0 + 1.0 Mg S/fed + 900, 450, 450 µg g^{-1} (Fe, Zn, Mn) by rate of increases 89.80% over control. For seed quality data show that an increases in P and K%, Fe, Zn and Mn µg g^{-1} ,oil and protein%, oil and protein yield upon treating by A_1 + 1.0 Mg S/fed + 900, 450, 450 µg g^{-1} (Fe, Zn, Mn). Generally, a combined application of amino acid with micronutrient Fe, Zn, Mn in the presence of elemental sulphur significantly increased the sesame yield; improved nutrition and increased seed quality; except the seeds yield whither the highest amount for seeds yield occurred in absence of amino acids; it was probably related to the physiological actions of amino acids and micronutrients. [Journal of American Science. 2010;6(11):250-257]. (ISSN: 1545-1003).

Key words: Amino acids- sulphur-micronutrients-sesame-sandy soil.

1. Introduction

Micronutrients are elements which are essential for plant growth, but are required in quite smaller amounts than those of the primary nutrients, nitrogen, phosphorus and potassium. They play an indispensable role in cell division and development of meristematic tissues, stimulate photosynthesis, respiration, energy and nucleotide transfer reactions and fasten the plant maturity (Marschner, 1998).Although micronutrients are needed in relatively very small quantities for adequate plant growth and production, their deficiencies induce a great disturbance in the different physiological and metabolic processes inside the plant.

Amino acids can directly or indirectly influence the physiological activities of the plant. Functionally, amino acids especially L- amino acids rather than D-amino acids are involved in the enzymes responsible for the structural photosynthesis process. Also, amino acids have act as chelating effect on micronutrients, when applied together with micronutrients, the absorption and transportation of micronutrients inside the plant is easier (Ibrahim, 2007). The requirement of amino acids in essential quantities is well known as a mean to increase yield and overall quality of crops. The application of amino acids for foliar spray is based on their requirement by plants in general and critical stages of growth in particular. Plants absorb amino acids through stomata and are proportionate to environment temperature that controls the opening mechanism of the plant stomata. Also amino acids are fundamentals ingredients in the process of protein synthesis. About 20 important amino acids are involved in the process of each function (Ewais *et al.*, 2005).Khalil *et al*., (2008) found that foliar spray of both amino acids and micronutrients together on onion plants could improve the onion yield and its components.

In oil seeds, sulphur plays a significant role in the quality and development of the seeds. Therefore, crops of oil seeds require a higher quantity of sulphur for proper growth, development for high yields (Mandal *et al*., 1993). Ceccotti (1996) recorded that sulphur plays an important role in the primary and secondary plant metabolism as a component of proteins, glucosinolates and other compounds that related to several parameter determining the nutritive quality of crops. Moreover, sulphur is an integral part of acyl-coenzyme A that helps synthesis of more fatty acid (Lal *et al.*, 1995).

Sesame (*Sesamum indictum*, L) is one of the most important crops grown for oil production in Egypt. The crop is grown for its seeds, which contain 50-60% oil, 8% protein, 5.8% water, 3.2% crude fiber, 18% carbohydrate, 5.7% ash and it is very rich in minerals such as Ca, P and vitamin E Dasharath *et al.* (2007). Also, sesame oil has a very high level of unsaturated acids, which is assumed to have reducing effect on plasma cholesterol, as well as on coronary heart disease (Agboola, 1979). Sesame seeds have a positive amino-acid structure- high level of methionine and low level of lysine; this makes it an excellent protein complement to other plant proteins. Obiajunwa *et al.* (2005) reported that Nigerian sesame seeds are rich in essential minerals and trace elements that promote well being in humans. Minerals are unique nutrients because of their important role in metabolism. They are essential part of many important enzymes and they also play roles as catalysts and antioxidants. They added that at a daily consumption rate of 100 g, the values of all the elements in sesame seed fall within the US recommended Dietary Reference Intakes (DRIS) (National Academy of Sciences, 1998). Neelam Sharma et al., (2007) found that sesame genotype contained high value of protein content in the range of 18.60 to 27.57 %. The moisture content was in the range of 3.14 to 4.40 % and ash content ranged from 4.20 to 6.20 %. Sesame seeds are good source of methionine (2.32 to 3.77 g / 16 g N) and tryptophan (1.03 to 1.95 g / 16 g N). Oxalate content varied from 475.32 to 987.19 mg / 100g, while the range of oil content was 32.00 to 50.36.In spite of its importance, little attention has been paid for its nutrient requirements, especially in newly reclaimed sandy soils. So the main target of the current investigation is to study the efficiency of amino acid, micronutrients Fe, Mn and Zn applied with different rates in the presence of sulphur on the yield, seed quality for sesames plant in sandy soils.

2. Materials and Methods

A field experiment was carried out at Ismailia Agricultural Research Station, for two successive summer seasons 2008 and 2009 using sesame (Giza 32) to study the effect of amino acids, micronutrients (Fe, Zn, Mn) and elemental sulphur and their interaction on sesame yield, its components and seed quality. Some physical and chemical characteristics of the studied soil are presented in Table (1) which, were determined according to Klute (1986) and Page et.al, (1982**)** .The experimental design was a randomized complete block with four replicates. The plot area was 10.5 m^2 (3 m width and 3.5 m length). The plots were ploughed twice in two ways and received superphosphate (15% P_2O_5) at rate 30 kg P_2O_5/fed and elemental sulphur at the rates (S_0) zero, (S_1) 0.5 Mg S/fed and (S_2) 1.0 Mg S/fed. Nitrogen and potassium fertilizers were added to all plots in two equal doses during the growing period in the form of ammonium nitrate (33.5% N) and, potassium sulphate (48% K_2O) at rates of 100 kg N/fed and 50 kg K_2O/fed, respectively.

The treatments of amino acids were (A_0) zero and (A_1) 2 g/l, while micronutrients Fe, Zn and Mn were added as mixture at rates of zero (T_0) & 450, 225, 225 µg g^{-1} (T_1) and 900, 450, 450 µg g^{-1} (T_2). They were added as foliar application at two times after 30 and 60 days from planting.

At harvest, plant samples were separated and seeds dried at 70 ºC ground in a Willy mill and digested with H_2SO_4 and H_2O_2 according to Parkinson and Allen (1975). The digested samples were analyzed for N, P and K; Fe, Zn, Mn by using Inductively Coupled Plasma Spectrometer (ICP) plasma 400 according to Cottenie et al., (1982). Oil of sesame seeds was determined according to A.O.A.C (1975). The obtained data (average of two seasons) were statistically analyzed according to S.A.S (2001).

Table (1): Some physical and chemical properties of the tested soil.

Characteristics	Value
§ **Particle size distribution (%):**	
Coarse sand	78.0
Fine sand	14.7
Silt	4.8
Clay	2.5
Texture class	Sandy
§ **Chemical analysis:**	
pH (1: 2.5, soil suspension)	7.7
Total carbonates (%)	0.41
Organic matter (%)	0.21
EC_e dS m^{-1}, soil paste	2.69
Soluble cations (meq/l)	
Ca^{++}	6.96
Mg^{++}	4.76
Na^{+}	14.60
K^{+}	0.62
Soluble anions (meq/l)	
$CO_3^{=}$	-
HCO_3^{-}	2.74
Cl^{-}	15.40
$SO_4^{=}$	8.80
Available N (µg g^{-1})	10.80
Available P (µg g^{-1})	4.60
Available K (µg g^{-1})	69.0
Available Fe (µg g^{-1})	2.50
Available Zn (µg g^{-1})	1.20
Available Mn (µg g^{-1})	1.58

3. Results and Discussion

Plant height (cm) for sesame yield:

Data in Table (2) show the effect of amino acids, sulphur and micronutrients on plant height for sesame yield**.** Data indicated that there were increases in the plant height (cm) by sulphur application, foliar application of Fe, Mn, Zn and/or amino acids. Generally, these increases were more obvious with foliar application of amino acids. The tallest plant height (213.3 cm) were achieved upon treating by amino acids 2g/l + 1.0 Mg S/fed + 900, 450, 450 µg g^{-1} Fe, Zn, Mn, by rate of increases 48.0% over control. The statistical analysis for the data indicated that plant height significantly affected by all applied treatments. Such results are in agreement with those recorded by Ibrahim *et al.* (2007) in faba bean found that foliar application of both amino acids and micronutrients significantly increased plant height, number of branches, leaf area as well as number of pods per plants and consequently the faba bean seed yield. This explained that foliar application of amino acids affects positively the plant growth and crop yield through :- 1) their role in quick nutrient absorption and systemic transportation through the aerial parts of plants.2) rapidly metabolized with subsequent formation of biologically useful substances i.e. chlorophyll and plant growth regulators. 3) Nutritional and reconstituent function with formation of proteins and carbohydrates. 4) Catalyst and biostimulant action on the activities of main enzyme systems. 5) Hormone like action of equilibrium and synergistic action with endogenous plant growth regulators. 6) Better transport and use of micronutrients. 7) Regulation of water equilibrium.

Table (2): Plant height (cm) for sesame yield as affected by amino acids, sulphur and micronutrients

Treatment	A_0 Plant height (cm)	A_1 Plant height (cm)	Means
$T_0\ S_0$	144.1	156.1	150.1
$T_0\ S_1$	163.5	165.8	164.7
$T_0\ S_2$	172.6	180.1	176.4
$T_1\ S_0$	151.3	163.6	157.5
$T_1\ S_1$	178.0	191.7	184.9
$T_1\ S_2$	188.3	193.8	191.1
$T_2\ S_0$	164.3	167.4	165.9
$T_2\ S_1$	198.0	198.8	198.4
$T_2\ S_2$	210.8	213.3	212.1
Means	174.5	181.2	

T_0 = zero Fe, Zn, Mn T_1 = 450, 225, 225 µg g^{-1}
T_2 = 900, 450, 450 µg g^{-1} S_0 = zero sulphur
S_1 = 0.5 Mg S/fed S_2 = 1.0 Mg S/fed
A_0 = without amino acids A_1= 2 g/l amino acid

L.S.$D_{0.05}$ for	Plant height
A (amino acids)	5.58**
T (micronutrients)	2.31**
A × T	3.27**
S (sulphure)	2.31**
A × S	3.27**
T × S	2.58**
A × T × S	3.65**
C.V	0.91

**highly significant * Significant

Sesame yields:

Data in Table (3) show the effect of amino acids, sulphur and micronutrients on seed weight (Kg/ha) and whole plant weight (Mg/ha) for sesame yield**.** Data indicated that there were significantly increases in the seed weight with increasing application of sulphur and micronutrients as foliar spray. Increasing the addition rate of S from 0.5 to 1.0 Mg S/fed and Fe, Zn, Mn from450, 225, 225 µg g^{-1} to 900, 450, 450 µg g^{-1} led to significantly increase the seed sesame yields. These increases were more obvious when amino acids sprayed in combination by rate of 2 g/l. The highest seed yields were achieved upon treating by A_0 + 1.0 Mg S/fed + 900, 450, 450 µg g^{-1} (Fe, Zn, Mn) by rate of increases 89.80% over control Fig (1). The statistical analysis for the data indicated that seed weight significantly affected by all applied treatments. Data also show that there were significantly increases in the whole plant weight with increasing application of sulphur and micronutrients as foliar spray. The highest plant weight were achieved upon treating by A_1 + 1.0 Mg S/fed + 900, 450, 450 µg g^{-1} (Fe, Zn, Mn) by rate of increases 50.04% over control Fig (1). The statistical analysis for the data indicated that plant weight significantly affected by S and micronutrients (Fe, Zn and Mn). The response of sesame yield to S application may be due to its effect on soil pH and increasing the availability of most of the nutrient elements, especially in sandy soil and presence of micronutrient and /or amino acids.

Table (3): Sesame yield as affected by amino acids, sulphur and micronutrients

Treatment	Seeds weight (Kg/ha)		Means	Whole plant weight (Mg/ha)		Means
	A_0	A_1		A_0	A_1	
$T_0\,S_0$	608	594	601	11.08	11.87	11.48
$T_0\,S_1$	665	698	682	13.15	13.32	13.24
$T_0\,S_2$	748	821	785	13.98	14.65	14.32
$T_1\,S_0$	620	698	659	11.99	13.20	12.60
$T_1\,S_1$	833	956	895	14.77	15.49	15.13
$T_1\,S_2$	872	1006	939	15.11	16.00	15.56
$T_2\,S_0$	778	800	789	12.79	13.54	13.17
$T_2\,S_1$	1052	1037	1045	16.48	17.12	16.80
$T_2\,S_2$	1154	1076	1115	17.62	17.81	17.72
Means	814	854		14.11	14.78	

$L.S.D_{0.05}$ for	Seeds weight	Whole plant weight
A (amino acid)	11.15**	N.S
T (micronutrients)	4.62**	3.16**
A × T	6.54**	
S (sulphure)	4.62**	3.16**
A × S	6.54**	
T × S	5.16**	
A × T × S	7.30**	
C.V	9.3	15.18

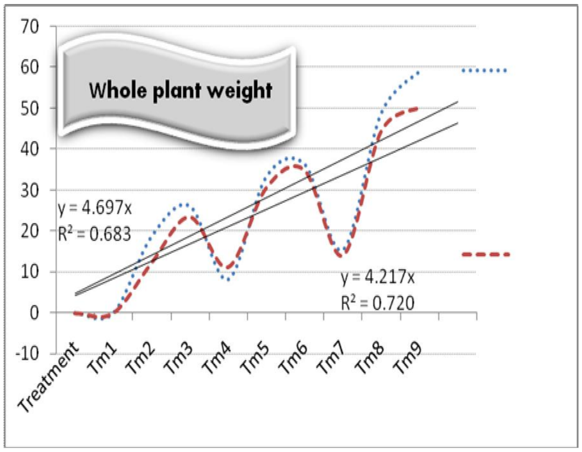
N.S. Not significant **highly significant * significant

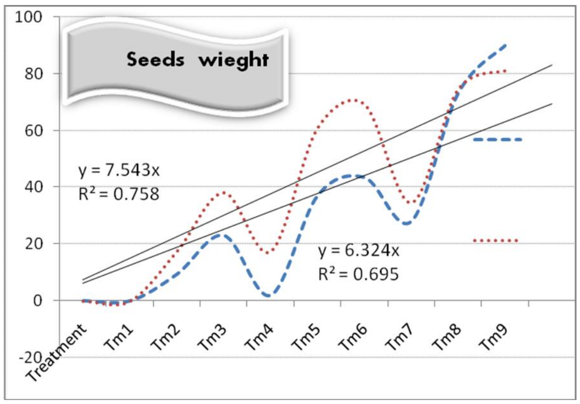
In this connection, Yadav *et al.* (1996) reported that S application significantly increased seed and straw yields of sesame. Fathi *et al.* (1999) observed that the application of elemental sulphur resulted in a significant increase in sesame yield. A positive response of sesame yield to S fertilization was associated with the rate of 1.0 ton S/fed. These results were confirmed with Salwa Eisa *et al.* (2009). On the other hand, Bekheta (2004), on wheat who found that foliar application for both amino acids and micronutrients led to obvious increases of grain and straw. This is because amino acids help to increases chlorophyll concentration in plant leading to higher degree of photosynthesis. This makes crops mush green and leads to more accumulation of the dry matter and subsequently increases the crop yield.

Seed quality:

Macro and micronutrients contents:

The effect of sulphur application, amino acids and Fe, Zn, Mn on the contents of macro and micronutrients in the yield of sesame seeds was recorded in Table (4) and (5). Data showed that Increasing the addition rate of S from 0.5 to 1.0 Mg S/fed and Fe, Zn, Mn from450, 225, 225 µg g^{-1} to 900, 450, 450 µg g^{-1} led to significantly increase in the P and K percentage and (Fe, Zn, Mn) µg g^{-1} in seed sesame yields. These increases were more obvious when amino acids sprayed in combination by rate of 2 g/l. The highest seed yields were achieved upon treating by A_1 + 1.0 Mg S/fed + 900, 450, 450 µg g^{-1} (Fe, Zn, and Mn). The corresponding values were 0.56 and 2.45% for P and K. The corresponding values were 333, 78 and 33 µg g^{-1} for Fe, Zn, and Mn. This is because the presence of acid form amendments as mineral sulphur, which improves the physical and chemical properties of soil, lowers soil PH, which well- known effects upon increasing the availability of elements in soil. Also, amino acids have act as chelating effect on micronutrients, when applied together with micronutrients, the absorption and transportation of micronutrients inside the plant is easier (Ibrahim, 2007).These results were confirmed with obtained by Khalil, *et al.* (2008) and Salwa Eisa *et al.* (2009). The statistical analysis for the data indicated that P% significantly affected by S and T& K% significantly affected by T treatments & Fe µg g^{-1} significantly affected by all treatments & Zn µg g^{-1} significantly affected by all treatments except A where Mn µg g^{-1} significantly affected by A, T and S treatments.





$Tm_1 = T_0 S_0$ $Tm_2=T_0S_1$ $Tm_3=T_0S_2$ $Tm_4=T_1S_0$ $Tm_6=T_1S_2$ $Tm_7=T_2S_0$ $Tm_8=T_2S_1$ $Tm_9=T_2S_2$

Fig (1): Rate of increases for whole plant weight and seeds sesame weight.

Table (4): Macronutrients content on Sesame seeds as affected by amino acids, sulphur and micronutrients

Treatment	P %		Means	K%		Means
	A_0	A_1		A_0	A_1	
$T_0 S_0$	0.50	0.50	0.50	2.30	2.31	2.30
$T_0 S_1$	0.51	0.52	0.51	2.34	2.34	2.34
$T_0 S_2$	0.52	0.52	0.52	2.36	2.37	2.36
$T_1 S_0$	0.52	0.51	0.51	2.29	2.32	2.30
$T_1 S_1$	0.53	0.54	0.53	2.36	2.36	2.36
$T_1 S_2$	0.53	0.54	0.53	2.40	2.38	2.39
$T_2 S_0$	0.52	0.54	0.53	2.41	2.43	2.42
$T_2 S_1$	0.54	0.55	0.53	2.42	2.44	2.43
$T_2 S_2$	0.55	0.56	0.54	2.44	2.45	2.44
Means	0.52	0.53		2.36	2.37	

$L.S.D_{0.05}$ for	P %	K %
A (amino acids)	N.S	
T (micronutrients)	0.02**	0.09*
A × T		
S (sulphure)	0.02**	N.S
A × S		
T × S		
A × T × S		
C.V	3.69	4.20

N.S. Not significant **highly significant
* significant

Oil and protein content:

The effect of sulp:hur application, amino acids and Fe, Zn, Mn on the oil and protein % and oil, protein yield contents of in the yield of sesame seeds was recorded in Table (6). Data showed that application of amino acids and micronutrients as foliar application in the absence of S led to a slight increase in seed oil % and oil yield content. In other words, applications of sulphur increase seed oil content, oil yield content either in the presence or absence of amino acid and micronutrients. Also, data show that, slight increases of oil % for all treatment over control, and there is no significant, difference in oil % between the treatments. This mainly, because it is genetically controlled. The highest seed oil % content was obtained upon treating by 1.0 Mg S/fed + 900, 450, 450 µg g^{-1} (Fe, Zn, and Mn) in the presence or absence of amino acids, where for oil yield the highest seed oil yield content was obtained upon treating by 1.0 Mg S/fed + 900, 450, 450 µg g^{-1} (Fe, Zn, and Mn). This is because the addition of elemental sulphur plays a significant role in the quality and development of the oil seeds. With this respect, Fathi (1999) recorded that S application alone up to 1.0 ton S/fed, significantly increased seed oil content of sesame. Similar observation was obtained by Salwa Eisa *et.al.*(2009). Data also showed that Increasing the addition rate of S to 1.0 Mg S/fed and Fe, Zn, Mn to 900, 450, 450 µg g^{-1} in the presence of amino acids led to increase in the protein % and protein yield contents. This is because plants make their proteins by synthesizing them from amino acids, which are produced by complex biochemical processes starting with the elements of nitrogen, carbon, oxygen and hydrogen. This process consumes biological and biochemical energy. Foliar application of pre-formed amino acids gives the plant its requirements and thereby saving biological energy (Ibrahim, 2007).

Table (5): Micronutrients content of Sesame seeds

Treatment	Fe (μgg^{-1})		Means	Zn (μgg^{-1})		Means	Mn (μgg^{-1})		Means
	A_0	A_1		A_0	A_1		A_0	A_1	
$T_0 S_0$	186	206	196	43	44	43.5	13	14	13.5
$T_0 S_1$	208	210	209	48	49	48.5	14	15	14.5
$T_0 S_2$	246	251	249	48	50	49.0	18	19	18.5
$T_1 S_0$	254	258	256	54	54	54.0	21	21	21.0
$T_1 S_1$	260	266	263	59	59	59.0	24	25	24.5
$T_1 S_2$	278	285	282	59	62	60.5	26	27	26.5
$T_2 S_0$	289	298	294	64	45	54.5	28	28	28.0
$T_2 S_1$	300	305	303	69	70	69.5	29	32	30.5
$T_2 S_2$	304	333	319	76	78	77.0	31	33	32.0
Means	258	268		58	57		23	24	

$L.S.D_{0.05}$ for	Fe	Zn	Mn
A (amino acids)	14.02**	N.S	6.65*
T (micronutrients)	5.81**	4.33**	2.75**
A × T	8.22*	6.13**	
S (sulphure)	5.81**	4.33**	2.75**
A × S	8.22*	6.13**	
T × S	6.49**	4.84**	N.S
A × T × S	9.18**	6.84**	
C.V	1.54	5.28	8.29

N.S. Not significant * significant **highly significant

Table (6): Oil & protein% and oil& protein yield in sesame seeds

Treatment	Oil %		Means	Protein %		Means
	A_0	A_1		A_0	A_1	
$T_0 S_0$	52	52	52.0	16.37	16.87	16.65
$T_0 S_1$	54	53	53.5	16.50	16.93	16.68
$T_0 S_2$	54	53	53.5	16.50	16.93	16.81
$T_1 S_0$	52	52	52.0	16.43	16.87	16.80
$T_1 S_1$	53	54	53.5	16.50	17.12	16.87
$T_1 S_2$	55	55	55.0	16.56	17.18	16.93
$T_2 S_0$	53	54	53.5	16.93	17.25	17.15
$T_2 S_1$	54	54	54.0	17.00	17.31	17.16
$T_2 S_2$	56	56	56.0	17.12	17.37	17.24
Means	53.6	53.6		16.65	17.09	

Treatment	Oil yield (Kg/ha)		Means	Protein yield (Kg/ha)		Means
	A_0	A_1		A_0	A_1	
$T_0 S_0$	316	309	312.5	99	100	99.5
$T_0 S_1$	359	370	364.5	110	118	114.0
$T_0 S_2$	404	435	419.5	123	139	131.0
$T_1 S_0$	310	363	336.5	98	118	108.0
$T_1 S_1$	442	516	479.0	137	164	150.5
$T_1 S_2$	480	553	516.5	144	173	158.5
$T_2 S_0$	412	432	422.0	132	138	135.0
$T_2 S_1$	568	560	564.0	179	180	179.5
$T_2 S_2$	646	603	624.5	198	187	192.5
Means	437.4	460.1		135.5	146.3	

L.S.D$_{0.05}$ for	Oil %	Protein %	Oil yield	Protein yield
A (amino acids)		1.04**	10.7**	10.6**
T (micronutrients)	1.82**	0.43**	4.45**	4.40**
A × T			6.29**	6.23**
S (sulphure)	1.82**	N.S	4.45**	4.40**
A × S			6.29*	N.S
T × S	N.S		4.97**	4.92**
A × T × S			7.02**	6.96**
C.V	2.37	1.79	0.69	2.18

N.S. Not significant **highly significant * significant

The statistical analysis for the data indicated that oil % significantly affected by micronutrients and elemental sulphur treatments & oil yield significantly affected by all treatments & protein % significantly affected by amino acids and micronutrients treatments and protein yield significantly affected by all treatments except amino acids + sulphure (A×S).

4. Conclusion

From above mentioned, results and under the conditions of this experiment, a combined application of the amino acids and micronutrients in the presence of elemental sulphure increased significantly sesame yield and improved seed quality; except the seeds yield whither the highest amount for seeds yield occurred in absence of amino acids; was probably related to the physiological actions of amino acids and micronutrients. In addition to improving sesame nutrition and quality, reduction in the dose of amino acids and micronutrients applied by foliar spray is of economic importance and may also lead to ecological benefits.

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