Original Research Article
Impact of Integrated Nutrient Management on Growth and Yields of Sesame (*Sesamum Indicum* L.) at lower *Gangetic* Alluvial Zone of West Bengal

ABSTRACT

Aims: To study the effect of organic manures and chemical fertilizers on growth and yields of Sesame.
Place and Duration of Study:A field experiment wasconducted in lower Gangetic alluvial soils of West Bengal atagricultural experimental farm of University of Calcutta, Baruipur, South 24 Parganas during summer season of 2021.
Methodology: The fieldexperiment was laid out in a randomized block design with eight treatments replicated thrice and the variety used was Sabitri. The treatments were: NPK@ 50:30:25+ Manganese Sulphate (5 kg/ hectare) (T1), FYM + NPK @ 35:23:23 (T2), NPK @ 21:23:23+ Seed treatment with Azospirillum (600 g/ha) + Phosphobacteria (600 g/ha) (T3), Seed treatment with turmeric powder @ 10 gm/kg, Soil application of Organic Amendment with FYM and Neem cake @150 kg/ha (1:1), Untreated check (T5), Application of soil ment (11.12 kg/ha) (T6), Application of Humic acid (3.6 kg/ha) (T7), Application of sea weed (2 ml/l of water) (T8), A uniform dose of FYM was applied to all the plots as basal.
Results: Maximum plant height (93.45 cm), dry matter accumulation (104.19 g/m2) and LAI (4.77), Length of capsule (3.38 cm), no. of capsule/plant (64.6), no. of seeds/capsule (77.62), grain yield (930.12 kg/ha) and straw yield (2676.97 kg/ha) were recorded from the application of NPK @ 21:23:23+ Seed treatment with Azospirillum (600 g/ha) + Phosphobacteria (600 g/ha) (T3).
Conclusion: The result of the presentstudy revealed that integrated application of NPK along with biofertilizers [NPK @ 21:23:23 + Seed treatment with Azospirillum (600 g/ha) + Phosphobacteria (600 g/ha)] gavehigher growth attributes, yield attributes and yield.

Keywords: Azospirillum, Integrated Nutrient Management, Phosphobacteria, Sesame,Straw yield,Grain yield

1. INTRODUCTION

"Sesamum (Sesamumindicum L.) also known as Till or Gingelly belongs to the genus sesamum and family Pedaliaceae. It is one of the important oilseed crops in India. Most sesamum wild relatives are found in sub-Saharan Africa, but also present in India in small numbers" (Bedigian, 2003 and Desai, 2004). "Among the oilseed crops, It is well known and is one of the oldest crops in the world" (Were et. al., 2006). Due to its high nutritional, medicinal, cosmetic and cooking qualities, it is known as 'the queen of oils'(Sabannavar et. al., 2008). "Oleic and linoleic acids are the predominant fatty acids of sesame oilthat have many dietary and health benefits for humans" (Arslan et. al., 2009). "Plants are erect to semi-erect depending on branching types; ovate to lanceolate leaves with pointed apices, the leaf margins are entire to serrate, and stem is round or square type. Flowers range in size containing small-sized tubular calyx and five-lobed corollas and colors, e.g., white, violet, red or maroon. Corolla is campanulate having a lower corolla lobe longer than the upper one with one sterile and four functional epipetalous stamens" (Ullah et. al., 2012).

"India ranks first in area, production and export of sesame in the world. Sesame ranks third in terms of total oilseed area and fourth in terms of total oilseed production in India. It is one of the important oilseed crops in West Bengal and mainly grown in marginal land with minimum care. The area, production and productivity of sesame are higher in summer season than those of post-kharif and kharif seasons" (Anonymous, 2006).

"Lower productivity of sesame is due to use of sub-optimal rate of fertilizer, poor management and cultivation of sesame in marginal and sub-marginal lands where deficiency of macronutrients such as nitrogen, phosphorus, potassium and micronutrient ispredominant. Sustainability of crop production is not a viable proposition either through use of organic manures or chemical fertilizers alone" (Singh et. al., 2009). "Use of chemical fertilizers alone increase the crop yields in the initial year adversely affected the sustainability at a later stage. Furthermore, the chemical fertilizers are in short supply, derived from non-renewable sources of energy and are costly. Use of organic and inorganic fertilizers in a balanced proportion for sustainable production of sesamum. Integrated use of organic manures and mineral fertilizers helps in maintaining stability in crop production, besides improving soil physical conditions.Detailed fertilizer studies have indicated the application of Nitrogen, Phosphorus and Potassium (NPK) fertilizer to sesame gives reasonable chance of increase in sesameyield" (Jakusko and Usman, 2013)."Adequate supply of nitrogen is beneficial for carbohydrates and protein metabolism, promoting cell division and cell enlargement. Similarly, good supply of phosphorus is usually associated with increased in root density and proliferation, which aid in extensive exploration and supply nutrients and water to the growing plant part, resulting in increased growth traits thereby ensuring more seed and dry matter yield. Analysis of mature sesame plants usually shows high potassium content especially in the capsules. Sesame being an oilseed crop, sulfur plays a remarkable role in protein metabolism. It is required for the synthesis of proteins, vitamins and chlorophyl and also sulphur containing amino acids such as cystine, cysteine and methionine which are essential components of proteins" (Kumar et. al., 2017). "Farmyard manure plays an important role in conserving soil moisture and improving soil texture and structure. It also sustains fertility status of soil. Neem cake is also rich source of nitrogen, phosphorous and potash and it has smothering effect for controlling weeds. Bioinoculants are the route to alternative strategy and many workers reported the beneficial effects of integrating biofertilizers on crop growth, yield and maintenance of soil fertility" (Pattanayak et. al., 2001). In addition, humic acid (HA) is one of the most important components of bioliquid complex. Because of its molecular structure, it provides numerous benefits to crop production. It helps break up clay compacted soils, assists in transferring micronutrients from the soil to the plant, enhances water retention, increases seed germination rates, improves water, air, and roots penetration, and stimulates development of microflora population in soils. Humic acid is not a fertilizer, but as considered as a compliment to fertilizer (Mackowiak et. al., 2001). On this respect, Wahdan et, al., (2006) and El-Bassiouny et. al., (2014) indicated that humic acid (HA) is not a fertilizer as it does not directly provide nutrients to plants, but is a compliment to fertilizer.

The field experiment was conducted with the main emphasis to study the effect of organic manures and chemical fertilizers on growth and yields of sesame.

2. MATERIAL AND METHODS

The experiment was conducted in lower Gangetic alluvial soils of West Bengal at agricultural experimental farm of University of Calcutta, Baruipur, South 24 Parganas (88°26" east longitude, 22°22" north latitude and 9.75 m magnitude) in thesummer season of 2021. The experiment was laid out in a randomized block design with eight treatments replicated thrice and the variety was Sabitri. The treatments usedwere: NPK@ 50:30:25+ Manganese Sulphate (5 kg/ hectare) (T1), FYM + NPK @ 35:23:23 (T2), NPK @ 21:23:23+ Seed treatment with Azospirillum (600 g/ha) + Phosphobacteria (600 g/ha) (T3), Seed treatment with turmeric powder @ 10 gm/kg, Soil application of Organic Amendment with FYM and Neem cake @150 kg/ha (1:1), Untreated check (T5), Application of soil ment (11.12 kg/ha) (T6), Application of Humic acid (3.6 kg/ha) (T7), Application of sea weed (2 ml/l of water) (T8), A uniform dose of FYM was applied to all the plots as basal. Soil was sandy loam in texture (Sand- 66.93%, Silt- 19.2%, Clay- 13.6%) and acidic (pH- 6.5) in reaction, with low to medium in soil fertility: organic carbon (0.52%), available nitrogen (390 kg/ha), available phosphorous (24.1 kg/ha), available potassium (185 kg/ha), available sulphur (6.5ppm) and available boron (0.61 ppm) and C.E.C value- 28.38 meq/100g of soil.

Plant height was measured in centimeter by a meter scale at differentgrowth stages and their average data were recorded per replication. Data were also recorded as the average of randomly selected five plants from the inner rows of each plot. Plant height the ground surface to the top of the main shoot and the mean height were expressed in cm.From the randomly selected five plants from each plot, all the capsule were stripped off and counted at the time of harvesting and the average number of capsules per plant was recorded.Capsule length was measured in centimeter (cm) scale from randomly selected plants. Mean value of them was recorded as treatment wise.Fivecapsules from each plot were randomly selected, Seeds were separated from those capsules and were counted. The average number of seed per capsule was recorded.The plant dry matter weight was taken by over dry method. Five plants samples randomly collectedat the 30, 45 and harvesting period were gently washed to remove sand and dust particles adhere to the plants.After then the samples were kept in an oven at 70^{o}C for 72 hours to attain constant weight. When the plant samples were attained at constant weight, the dry weights were recorded.After harvesting the plant was sun-dried and threshed by pedal thresher. Seed and straw were properly sun-dried and their weights recorded.

The data collected from the field were subjected to statistical analysis appropriate to the design Randomized Block Design (RBD) by following the procedure laid out by Gomez and Gomez, 1984. The significance of different sources of variations was tested by Fisher and Snedecor's F-test at probability level of 0.05. For the determination of critical difference at 5% level of significance, the statistical table's formulation by Fisher and Yates (1979) were consulted.

3. RESULTS AND DISCUSSION

3.1 Growth attributes

Growth attributes of sesame was affected significantly by integrated application of fertilizer in different treatments over control (Table 1). It is evident from data that plant height varied from 19.36 cm to 23.10 cm (30 days after sowing), 29.95 cm to 33.65 (45 days after sowing) and 89.86 to 93.95 (At harvest) and was significant among the all treatments. Maximum plant height (23.10 cm, 33.65 cm and 93.45 cm in 30, 45 and at harvest respectively) obtained with application of NPK @ 21:23:23+ Seed treatment with Azospirillum (600 g/ha) + Phosphobacteria (600 g/ha) (T3). Minimum plant height was recorded in every stage of crop growth with water spray (T5) due to less supply of nutrients in the growth stages of sesame.

Data pertaining to dry matter accumulation (Table 1) revealed that the application of nutrients influenced the dry matter accumulation significantly and varied from 11.51 to 18.40 g/m2 at 30 days after sowing. Maximum dry matter accumulation 18.40 g/m2 obtained with application of NPK @ 21:23:23+ Seed treatment with Azospirillum (600 g/ha) + Phosphobacteria (600 g/ha) (T3) at par with NPK@ 50:30:25+ Manganese Sulphate (5 kg/ hectare) (17.72 g/m2) (T1) and FYM + NPK @ 35:23:23 (17.50 g/m2) (T2). At 45 days after sowing, maximum dry matter accumulation 75.47 g/m2 obtained with application of NPK @ 21:23:23+ Seed treatment with Azospirillum (600 g/ha) + Phosphobacteria (600 g/ha) (T3) at par with NPK@ 50:30:25+ Manganese Sulphate (5 kg/ hectare) (74.74 g/m2) (T1) and FYM + NPK @ 35:23:23 (74.56 g/m2) (T2) and minimum dry matter accumulation (66.84 g/m2) was recorded with water spray (T5). Dry matter accumulation varied from 95.20 to 104.19 g/m2 at harvest. Similar kind of trends were also followed at harvest.

Maximum LAI (Table 1) 3.49 (30 days after sowing), 3.97 (45 days after sowing) and 4.77 (At harvest) obtained with application of NPK @ 21:23:23+ Seed treatment with Azospirillum (600 g/ha) + Phosphobacteria (600 g/ha) (T3).

It is interesting to note that NPK @ 21:23:23+ Seed treatment with Azospirillum (600 g/ha) + Phosphobacteria (600 g/ha) (T3) recorded higher plant height, dry matter accumulation and leaf area index than other treatments. "Integrated nutrient management are reported to be the best option to increase the growth parameters of the crops and maintaining soil health" (Pattanayak*et. al.,* 2001; Deshmukh *et. al.*, 2002; Verma *et. al*., 2012). "This may be due to supply of nutrients from diversified sources and prolonged availability of nutrients to the growing plants. The beneficial role of free-living nitrogen fixing microorganisms for enhancing plant growth through their ability in nitrogen fixation as well as the effect of their metabolites secretion on the crop may also be attributed for the same. These results are in agreement with Jaishankar and Wahab" (2005).

Table 1: Effect of integrated nutrient management on plant height, dry matter accumulationand leaf area index.

Treatments	Plant height (cm)			Dry matter accumulation (g/m2)			LAI		
	30 DAS	45 DAS	At harvest	30 DAS	45 DAS	At harvest	30 DAS	45 DAS	At harvest
T1- NPK@ 50:30:25+ Manganese Sulphate (5 kg/ hectare)	22.94	33.51	93.42	17.72	74.74	103.50	3.38	3.62	4.61
T2- FYM + NPK @ 35:23:23	21.36	33.13	93.06	17.50	74.56	102.82	3.30	3.57	4.60
T3- NPK @ 21:23:23+ Seed treatment with Azospirillum (600 g/ha) +	23.10	33.65	93.45	18.40	75.47	104.19	3.49	3.97	4.77

Phosphobacteria (600 g/ha)									
T4- Seed treatment with turmeric powder @ 10 gm/kg, Soil application of Organic Amendment with FYM and Neem cake @150 kg/ha (1:1)	21.03	32.69	92.46	16.03	72.61	101.11	3.22	3.22	4.54
T5- Untreated check	19.36	29.95	89.86	11.51	66.84	95.20	2.57	2.62	4.20
T6- Application of soil ment (11.12 kg/ha)	20.36	32.20	91.80	15.38	71.04	99.76	2.83	3.09	4.32
T7 - Application of Humic acid (3.6 kg/ha)	20.00	31.30	91.56	15.19	70.91	98.02	2.74	2.99	4.25
T8 – Application of sea weed (2 ml/l of water)	19.66	30.32	90.40	15.08	69.26	96.62	2.65	2.74	4.21
SE(m±)	0.74	0.66	0.59	0.30	0.31	0.39	0.20	0.15	0.12
CD(P=0.05)	2.24	2.02	1.80	0.93	0.95	1.18	0.61	0.46	0.39
CV (%)	5.34	3.14	0.97	3.35	0.75	0.67	10.06	7.25	4.42

NPK- Nitrogen, Phosphorous and Potash; Kg- Kilogram; FYM- Farmyard manure; Ha- Hectare; G- Gram; Ml- milliliter; L- Litre; SE(m±)- Standard error of the mean; CD- Critical Difference; CV- Coefficient of variation.

3.2 Yield Attributes

It is evident from the data (Table 2) that application of nutrient brought significant variation in Length of capsule, No. of capsule/plant and No. of seeds/capsule and varied from 1.73 to 3.38 cm, 43.00 to 64.60 and 61.09 to 72.62 respectively. A close examination of the data (Table 2) indicated that the maximum ength of capsule (3.38 cm), No. of capsule/plant (64.60) and No. of seeds/capsule (72.62) were recorded with application of NPK @ 21:23:23+ Seed treatment with Azospirillum (600 g/ha) + Phosphobacteria (600 g/ha) (T_3). The lowest results (1.73, 43.00 and 61.09 respectively) were recorded with application of Water spray (control) (T5). This might be due to more availability of nutrients by NPK, Azospirillum (600 g/ha) and Phosphobacteria (600 g/ha)which resulted into higher uptake of nutrients by sesamum plant. Similar observations yield attributes were reported by Abo-El-Wafa*et. al.,* (2006) and Anandan *et. al.,* (2012).

Table 2: Effect of integrated nutrient management on length of capsule, no. of capsule/plant and no. of seeds/capsule.

Treatments	Length of capsule (cm)	No. of capsule/plant	No. of seeds/capsule
T1- NPK@ 50:30:25+ Manganese Sulphate (5 kg/ hectare)	3.27	64.2	77.50
T2- FYM + NPK @ 35:23:23	2.92	63.4	76.85
T3- NPK @ 21:23:23+ Seed treatment with Azospirillum (600 g/ha) + Phosphobacteria (600 g/ha)	3.38	64.6	77.62
T4- Seed treatment	2.60	62.00	73.71

with turmeric powder @ 10 gm/kg , Soil application of Organic Amendment with FYM and Neem cake @150 kg/ha (1:1)			
T5- Untreated check	1.73	43.00	61.09
T6- Application of soil ment (11.12 kg/ha)	2.59	58.60	70.69
T7 - Application of Humic acid (3.6 kg/ha)	2.48	56.70	67.85
T8 – Application of sea weed (2 ml/l of water)	2.19	55.5	64.41
SE(m±)	**0.15**	0.99	0.54
CD(P=0.05)	**0.47**	3.00	1.64
CV (%)	**9.04**	2.56	1.15

NPK- Nitrogen, Phosphorous and Potash; Kg- Kilogram; FYM- Farmyard manure; Ha- Hectare; G- Gram; Ml- milliliter; L- Litre; SE(m±)- Standard error of the mean; CD- Critical Difference; CV- Coefficient of variation.

3.3 Yield

Sesame crop, fertilized with NPK @ 21:23:23 + Seed treatment with Azospirillum (600 g/ha) + Phosphobacteria (600 g/ha) (T_3) produced highest seed yield and stover yield (930.12 kg/ha and 2676.97 kg/ha respectively) (Table 3) and at par with NPK@ 50:30:25+ Manganese Sulphate (5 kg/ hectare) (899.76 kg/ha and 2646.02 kg/ha respectively) (T_1), FYM + NPK @ 35:23:23 (855.80 kg/ha and 2626.65 kg/ha respectively) (T_2) followed by Seed treatment with turmeric powder @ 10 gm/kg, Soil application of organic amendment with FYM and Neem cake @150 kg/ha (1:1) (T_4), Application of soil amendment (T_6), Application of Humic acid (T_7) and Application of sea weed (T_8). Minimum seed and stover yield were recorded with control plot (water spray)(569.58 kg/ha and 1728.67 kg/ha respectively). Improvement of seed and stover yield are due to combined application of NPK along with Biofertilizers.

FYM provides a balanced supply of essential nutrients like nitrogen (N), phosphorus (P), and potassium (K), along with secondary nutrients and micronutrients. These nutrients are crucial for the growth and development of sesame plants, leading to better seed and stover yields and biofertilizers enhance nutrient availability in the soil. For example, nitrogen-fixing bacteria (such as Rhizobium) can convert atmospheric nitrogen into a form that plants can use. Mycorrhizal fungi improve phosphorus uptake. This leads to improved plant growth and yield.

In case of T3 integrated use of fertilizer was done by combined application of NPK along with higher doses of Biofertilizers helps to get higher seed and stover yield in sesame.These results are in agreement with Imayavaramban *et. al*., (2002) and Verma *et. al*., (2012).

Table 3: Effect of integrated nutrient management on seed yield (kg/ha) and stover yield (kg/ha).

Treatments	Seed yield (kg/ha)	Stover yield (kg/ha)
T1- NPK@ 50:30:25+ Manganese Sulphate (5 kg/ hectare)	899.76	2646.02
T2- FYM + NPK @ 35:23:23	855.80	2626.65
T3- NPK @ 21:23:23+ Seed treatment with Azospirillum (600 g/ha) + Phosphobacteria (600 g/ha)	930.12	2676.97
T4- Seed treatment with turmeric powder @ 10 gm/kg, Soil application of Organic Amendment with FYM and Neem cake @150 kg/ha (1:1)	824.96	2536.75
T5- Untreated check	569.58	1728.67

T6- Application of soil ment (11.12 kg/ha)	695.44	2177.59
T7 - Application of Humic acid (3.6 kg/ha)	683.95	2074.56
T8 – Application of sea weed (2 ml/l of water)	631.99	1835.16
SE(m±)	24.65	23.79
CD(P=0.05)	74.78	72.16
CV (%)	5.60	1.80

NPK- Nitrogen, Phosphorous and Potash; Kg- Kilogram; FYM- Farmyard manure; Ha- Hectare; G- Gram; Ml- milliliter; L- Litre; SE(m±)- Standard error of the mean; CD- Critical Difference; CV- Coefficient of variation.

4. CONCLUSION

Integrated Nutrient Management is one of the important issues for sustainable crop production. The result of the study revealed that integrated application of NPK along with biofertilizers [NPK @ 21:23:23 + Seed treatment with Azospirillum (600 g/ha) + Phosphobacteria (600 g/ha)] recorded higher growth attributes, yield attributes and yield. Farmers can use this for getting better sesame production.

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

Option 2:

Author(s) hereby declare that generative AI technologies such as Large Language Models, etc have been used during writing or editing of manuscripts. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology

Details of the AI usage are given below:

1.

2.

3.

REFERENCES

Abo-El-Wafa, A. M. and Abd-El-Lattief, E. A. 2006. Response of some sesame (Sesamum indicum L.) cultivars to fertilization treatments by micronutrients, bio-fertilizers and humix. Asian J. Agr. Sci. 37: 55-65.

Anandan, P. and Natarajan, S. 2012. Effect of integrated nutrient management on growth and yield of sesame cv. Svpr 1. Plant Arch. 12: 745-747.

Anonymous. 2006. Package of Organic Practices for Brinjal, Rice, Sesame and Taro.

Arslan Ç, Uzun B U, Ülger S C, İlhanÇağırgan M I 2007. Determination of oil content and fatty acidcomposition of sesame mutants suited for intensive management conditions. J Am Oil Chem Soc. 84:917–920.

Bedigian D. Sesamum in Africa: origin and dispersals. Food, Fuel and Fields: Progress in African Archaeobotany. Cologne: Heinrich Bert Institute, 2003, 17-36.

Desai BB. Seeds handbook: Processing and storage. CRC press. Dekker, New York, 2004.

Deshmukh M R, Jain H C, Duhoon S S, Goswami U 2002. Integrated nutrient management in sesame for Kymore plateau zone of M.P. Journal of Oilseeds Research; 19(1): 73-75.

Development Research Communication and Services Centre. Available from http://www.drcsc.org

El-Bassiouny, H. S. M., B. A. Bakry, A. A. Attia and M. M. Abd Allah (2014). Physiological role of humic acid and nicotinamide on improving plant growth, yield, and mineral nutrient of wheat (Triticum durum) grown under newly reclaimed sandy soil. Agric. Sci.,5: 687-700.

Fisher, R.A. and Yates, F. (1938) Statistical Tables for Biological, Agricultural, and Medical Research. Oliver and Boyd, London, 20, Example 12.

Gomez, K.A. and Gomez, A.A. (1984) Statistical Procedures for Agricultural Research. 2nd Edition, John Wiley and Sons, New York, 680 p.

Imayavaramban V, Thanunathan K, Singaravel R, Manickam G. 2002. Studies on the influence ofintegrated nutrient management on growth, yield parameters and seed yield of sesame (Sesamumindicum L.). Crop Research. 24(2): 309-313.

Jaishankar S, Wahab K. 2005. Effect of integrated nutrient management on the growth, yield components and yield of sesame. Sesame and Safflower Newsletter. 20: 732.

Jakusko BB, Usman BD (2013) Effects of npk fertilizer and plant population density on productivity of sesame (Sesamum indicum L.).Res J Agric Environ Manag 2 : 121—126.

Kumar S, Meena RS, Yadav GS, Pandey A (2017) Response of sesame (Sesamum indicum L.) to sulfur and lime application under soil acidity. Int J Pl Soil Sci 14 : 1—9.

Mackowiak, C.L., P.R. Grossl and B.G. Bugbee (2001). Beneficial effects of humic acid on micronutrient availability to wheat. Soil Sci.Soc.Am. J., 65:1744-1751.

Pattanayak S K, Mohanty R K and Sethy A K 2001. Response of okra to Azotobactor, Azospirillium and FYM. Second North Eastern Regional Conference on Biofertilizers, Assam Agricultural University,Jorhat, Assam.

Sabannavar S J, Lakshman H C 2008. Interactions between azotobacter, pseudomonas and arbuscularmycorrhizal fungi on two varieties of (Sesamum indicum L.). J Agron Crop Sci.194:470–478.

Singh S P, Dhayani B P, Shahi U P, Kumar Ashok, Singh R R, Kumar Y, Kumar S and BaliyanVikash2009. Impact of Integrated Nutrient Management on yield and nutrient uptake in rice (Oryza sativa)-Wheat (Triticum aestivum) under rice-wheat cropping system In sandy loam soil. Indian Journal ofAgril. Sc.; 79: 65-69.

Ullah N, Mirza MY, Jilani G, Khan MA, Zhou W. Sesamum: Breeding, 2012, 1. DOI: 10.1007/978-1-4614-0356-2-5.

Verma S, Saxena R, Singh H V 2012. Integrated nutrient management in sesame (Sesamum indicum L.). Bioinfolet. 9(4), 576-579.

Wahdan, A. A. A., A. A. Awadalla and M. M. Mahmoud (2006). Response of some wheat-maize cropping sequence in a calcareous soil to some mineral or chelatedmicronutrient forms added to soil in combination with sulphur and organic manures. Fayoum J. Agric. Res. and Dev., 20(1): 25-39.

Were BA, Onkware AO, Gudu S, Welander M, Carlsson AS. 2006. Seed oil content and fatty acidcomposition in east African sesame (Sesamum indicum L.) accessions evaluated over 3 years. FieldCrop Res. 97:254–260.