INNSPUB

International Journal of Agronomy and Agricultural Research (IJAAR)
ISSN: 2223-7054 (Print) 2225-3610 (Online)
http://www.innspub.net
Vol. 9, No. 1, p. 16-24, 2016

RESEARCH PAPER OPEN ACCESS

Impact of nitrogen fertilizer from organic and conventional sources on seed yield of Niger (*Guizotia abyssinica* Cass.)

Monaswita Talukdar[1], P B S Bhadoria[1], Subhash Chandra Mahapatra[2]

[1] *Agricultural and Food Engineering Department, IIT Kharagpur, India*

[2] *Rural Development Centre, IIT Kharagpur, India*

Article published on July 17, 2016

Key words: Niger, organic sources, Vermicompost, Bonemeal, Minor oil seed crop, Oilcake.

Abstract

Niger (*Guizotia abyssinica* Cass.), a minor oil seed crop cultivated on marginal and sub marginal lands under poor or neglected nutrient management practices in India has a good production potential even under low nutrient input conditions. However, not much study has been made on nutrient management practices for optimising plant growth and thereby seed yield. The study was undertaken to determine the growth and seed yield response of Niger to different nitrogen sources in rainfed acid lateritic uplands. Nitrogen was applied through chemical (Urea) and organic sources (Vermicompost, Mustardoilcake and Bonemeal) separately and in combination of these at two levels (30 and 60 kg ha^{-1}) in consecutive two years (2013-'14 and 2014-'15). Maximum seed yield (580 kg ha^{-1}) and dry matter yield (4530 kg ha^{-1}) of Niger were obtained where oilcake was applied in combination with chemical nutrients. However, varying sources or level of nitrogenous nutrients had no impact on oil content in seeds of Niger. Among the various sources of Nitrogen, combination of oilcake and chemical provided sufficient amount of Nitrogen to the soil which was observed through highest uptake as well as leftover available Nitrogen in soil.

* **Corresponding Author:** Monaswita Talukdar ✉ monaswita.talukdar@iitkgp.ac.in

Introduction

Presently, few oil seed crop species like groundnut (*Arachis hypogaea*), mustard (*Brassica juncea*), soybean (*Glycine max*) and sunflower (*Helianthus annuus*) mitigate the international demand of edible oil. But the search for good quality edible oil is still continuing to supply oil to the increasing population which is possible by not only increasing the production of major oil seed crops but also improving the production of several minor oil seed crops like Niger (*Guizotia abyssinica*) through agronomic interventions. Niger seed oil can help in managing human health problems with its fatty acid composition and presence of high amount of fat soluble bioactive components (Dutta *et al*., 1994; Ramadan and Moersel, 2002a; 2002b; 2004). The production and productivity of oil seed crops are dependent on different agro-climatic conditions. On the contrary, Niger even though considered as minor oil seed crop provides satisfactory yield under poor agronomic practices like low soil fertility, low crop management and moisture stress condition (Ranganatha 2010). Niger belongs to the family *Astaracea*, resembling same fatty acid profile as sunflower and provides 50% of Ethiopia's domestic edible oil and 2% of India's total oil seed production (Ramadan M.F. and Morsel J.T. 2002a). Apart from its use as edible cooking oil, Niger seed oil is also used as adulterant for other oils, soap, paint, illumination, making cakes. The protein rich oilcake after extracting oil can be used as feed, manure or fuel. In spite of its various utility, this crop still remains neglected from researchers which might have led to its poor production.

Fertilizer requirement of Niger is usually neglected and the crop is generally grown under poor or no nutrient management practices (Ranganatha 2010). The problem is more acute particularly under acid lateritic uplands where the soil is marked by low water retention capacity, poor availability of nutrients and low organic matter content due to the presence of high amount of inorganic acids which make the soil strongly acidic causing it more susceptible to nitrogen leaching loss (Agronomic acumen Newsletter November 2001 No. 80). Moreover, due to irregular distribution of monsoon rains the lands experience periodic drought sometimes even in the critical stages of crop growth causing serious damage in yield. However, higher productivity can be achieved under proper application of manure and fertilizer (Ranganatha 2010).

The impact of nitrogen on seed yield of Niger has been studied at different agro-climatic regions but information on the same is very scanty under rainfed acid lateritic soil condition. Though, the impact of nitrogen supply on the performance of Sunflower, one of Niger's nearest family members has been studied extensively. Deficiency in nitrogen induces several morphological and physiological hazards like growth retardation, decreased leaf number and leaf area (Nasim *et al.* 2012) besides total biomass accumulation and thereby duration of vegetative growth period.

Depending upon the availability in soil, application of nitrogen (@ 20 to 60 kg ha^{-1}) resulted significant increase in Niger seed yield. Though, according to some researchers nitrogen alone is not enough to give expected yield rather, combined application of N, P and K is most effective. Organic materials contain significant amount of macro as well as many micro-nutrients while, chemical fertilizers generally contain only macro nutrients. Therefore, continuous use of chemical fertilizers may lead to deterioration of soil health. Field crops may suffer from micro-nutrient deficiency. It may be said that neither organic nor chemical fertilizer alone can supply desired nutrient to crop plants and thereby the high yield whereas, the combination of both can achieve the expected result besides improvement of soil physical, chemical and biological conditions.

The main objective of this research work is to determine the effect of nitrogen applied through chemical and organic sources separately and in combination of these on plant growth and seed yield parameters of Niger.

Materials and methods

Experimental site

To achieve the objectives of the program, Niger plants were grown in acid lateritic upland soils under rainfed condition. The field experiments were conducted in two consecutive monsoons during 2013-'14 and 2014-'15 in the Crop Production cum Demonstration Farm of Rural Development Centre at IIT Kharagpur (22°33" N, 87°33" E), which represents the lateritic belt of south-western region of West Bengal, India. The region is marked by its warm and humid climate with an average annual rainfall of 1140 mm, most of which is received from middle of June to middle of October.

Soil characteristics

The soil samples collected from field were air dried, grounded with mortar pestle and sieved in 2 mm sized mesh (Brady 1990). The soil is acid lateritic having sandy loam texture with sand (62%), silt (12.65%) and clay (25.35%) mixed with lateritic pebbles. Soil pH is 5.79. The soil contains Organic C (0.36%), available N (143.031kg ha^{-1}), available P (10.87 kg ha^{-1}), available K (93.51kg ha^{-1}).

Experimental Design and Fertilizer Treatments

The experiment was conducted in randomized complete block design (RCBD) with three replications in the monsoon seasons of 2013 and 2014 to study the effect of Nitrogen fertilizer from organic and conventional Sources on Seed Yield of Niger (*Guizotia abyssinica* Cass.). The main factors affecting the study were different sources and levels of Nitrogen. Organic sources of N nutrient were Vermicompost (V_C) with 1.44% N, Mustard oilcake (O_C) with 5.21% N and Bone meal (B_M) with 4.0% N while inorganic source of N fertilizer was Urea (CH_4N_2O) with 45% N. There were total fifteen treatments (2 N level X 7 Sources = 14 + 1 Control). Plot size was 5 m X 4 m. The treatments are individual sources (4Nos.) and Combinations (3Nos.) all at 2 levels and control where no fertilizer were applied. In sole Vermicompost treatments 4166.7 gm Vermicompost for 1st level and 8333.33 gm for 2nd level per plot, in Oil Cake treatments 1151.63 gm Oilcake for 1st level and 2303.26 gm for 2nd level per plot, in Bonemeal treatments 1500 gm Bonemeal for 1st level and 3000 gm for 2nd level per plot, in chemical fertilizer treatments 133.33 gm Urea for 1st level and 266.67 gm for 2nd level per plot, in combined application of Vermicompost and chemical fertilizer 2083.33 gm Vermicompost and 66.67 gm Urea for 1st level and 4166.7 gm Vermicompost and 133.33 gm Urea per plot, In combined application of Bonemeal and chemical fertilizer fertilizer 750 gm Bonemeal and 66.67 gm Urea for 1st level and 1500 gm Bonemeal and 133.33 gm Urea per plot, in combined application of Oilcake and chemical fertilizer 575.82 gm Oilcake and 66.67 gm Urea for 1st level and 1151.63 gm Oilcake and 133.33 gm Urea per plot were applied. In control treatment no additional nutrients were added.

All organic sources of nutrients were incorporated in the soil before sowing while nutrients from chemical sources (in case of both sole and in combination with organic) were applied in split doses , one at the time of sowing and the other at the peak vegetative growth i.e. at 60 days after sowing (DAS).

Test Crop

Niger (cv. BNS-10, 120 days duration) was taken as test crop. Seeds were sown at the spacing of 15 cm (plant to plant) and 30 cm (row to row).

Observations on plant growth parameters and yield attributes

Plant height (cm), Number of leaves and leaf area (sq. cm per plant)were measured periodically at 30, 60, 90 day after sowing (DAS) and number of capitula per plant, dry biomass weight (kg ha^{-1}), seed yield (kg ha^{-1}) and oil content (%) were recorded at harvest.

Leaf Area Index

The LAI was calculated by using the method described by Watson (1952).

LAI= Leaf area/Land area

Nitrogen estimation

Nitrogen uptake by plant and available with the soil were estimated by analysing the soil and plant samples collected at harvest using Kjeldahl method (Chapman and Pratt, 1961).

Statistical Analysis

The experimental data collected during the crop growth and at harvest were analysed statistically following the procedure as described by Gomez and Gomez (1984). Treatment differences were tested at 5% level of significance by 'F' test and using analysis of variance (ANOVA) for making comparison among treatments means for various yield and yield components of Niger. Least significance difference (LSD) was done at $P = 0.05$.

Results and discussions

Effect on plant height

Application of Nitrogenous nutrient irrespective of sources or levels showed positive response with respect to plant height of Niger plant. (Fig. 1 and 2). However, higher plant height was found in the treatment where oilcake was combined with chemical nutrients at higher level (60 kg ha^{-1}). Though, initially (after 30 DAS) plant height was higher in the treatments where only chemical fertilizer was applied followed by organic and chemical sources and only organic sources. This might be due to the instant supply of available nutrients to the plants from chemical source. After 60 DAS the plants of all the treatment combinations including the treatments where only organic sources were applied started to increase in height and this may be due to the gradual decomposition and nutrient release from organic fertilizer. EI-Awag *et al.* (1996) observed that when urea was applied with some organic nutrients, urea increases the decomposition of organic nutrients and thereafter the release of nutrients in plant available form substantially enhances. After 120 DAS height of the plants was higher to that of other treatments in the treatments where combination of organic and chemical nutrients were applied and incidentally these treatments showed higher N uptake (Fig. 5 and 6) though there was not much differences in height with the increase in nutrient level in both years (Fig. 1 and 2). Melo and De- Oliveira (1999) reported that organic matter provides the plant not only with the minerals but various growth inducing hormones and vitamins also and thereby helps plant to grow more vigorously. Aracnon *et al.* (2004) reported that vermicompost provided a positive result on the growth of strawberries.

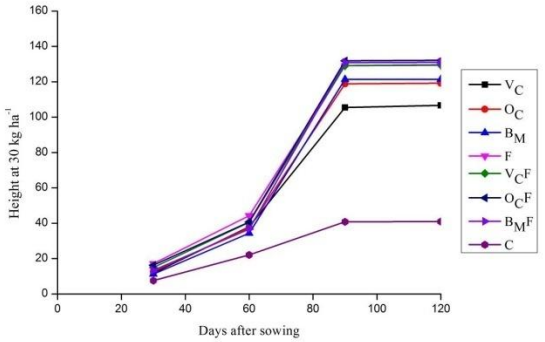

Fig. 1. Effect of various Nitrogenous nutrients at the rate 30 kg ha^{-1}on height of Niger.

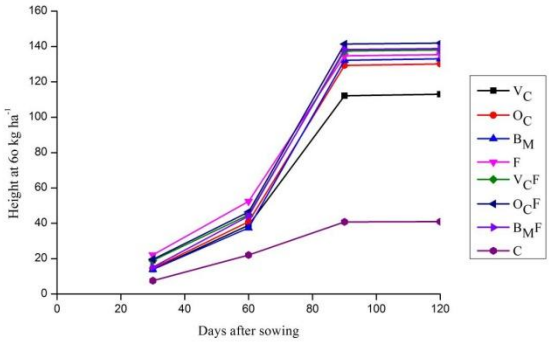

Fig. 2. Effect of various Nitrogenous nutrients at the rate 60 kg ha^{-1}on height of Niger.

Effect on plant leaf area index (LAI)

Leaf Area Index (LAI) progressively increased in all the treatments and maximum value was recorded at 90 DAS and the value started decreasing thereafter. It was maximum in combined application of oilcake and chemical fertilizer at the higher nutrient level even though initially in every treatment LAI was same. However, there was little difference in LAI value between two nutrient levels and in different treatment combinations indicating that Niger plant requires a

lower dose of nutrient for its growth and leaf expansion (Fig. 3 and 4). Effect of N availability on leaf growth was extensively studied by Nasim *et al.* (2012) and they described the availability of N to the sensitivity of leaf growth. The higher leaf expansion could be attributed to enhanced rate of cell division and cell enlargement which is possible only when nutrient availability is higher.

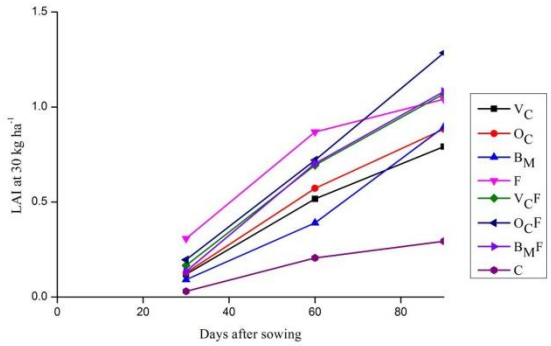

Fig. 3. Effect of various Nitrogenous nutrients at the rate 30 kg ha^{-1}on Niger leaf area index.

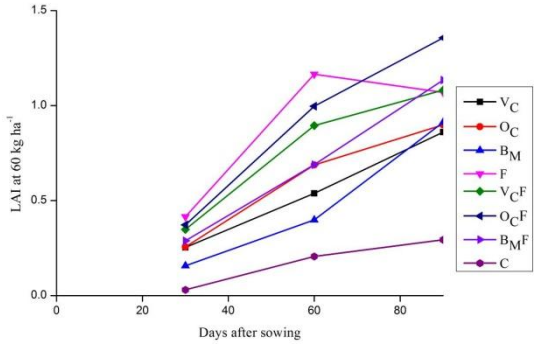

Fig. 4. Effect of various Nitrogenous nutrients at the rate 60 kg ha^{-1}on Niger leaf area index.

Effect on yield and yield attributes

Data presented in Table 1 revealed that the seed and biomass yield and various yield attributes like number of capitula per plant were affected significantly due to application of different nitrogenous nutrient from organic and inorganic sources, individually or/and their combinations compared to control. The soils of the experimental plots contained a low amount of organic C (0.36%) and a moderate amount of available N (143.031kg ha^{-1}). Under such circumstances, addition of N from organic materials and inorganic sources increased the N level and organic C in the soils of the plots where either organic nutrient alone or in combination with chemical nutrient were applied. This finding corroborates with the findings of Nel *et al.* (2000); Salehi and Bahrani (2000); Nawar and EI-Kafoury (2001); Gajendra and Giri (2001 and Ibrahim *et al.* (2003).

Table 1. Effect of various Nitrogen sources and doses on yield and yield parameters of Niger (pulled data of 2013-'14 and 2014-'15).

Dose of Nitrogen: 30 kg ha^{-1}

Treatments	Nos. of Capitula plant^{-1}	Seed Yield (kg ha^{-1})	Biomass Yield (kg ha^{-1})	Oil Content (%)
V_C	54.52 c	299.70 e	2459.01 cd	31.32 ns
O_C	58.38 bc	319.95 d	2691.93 bc	32.07 ns
B_M	56.70 c	324.54 d	2458.60 cd	31.71 ns
F	65.59 b	450.65 c	3031.89 b	30.39 ns
V_C + F	70.29 a	564.89 b	4345.55 a	31.25 ns
O_C+ F	72.14 a	579.57 a	4530.49 a	30.91 ns
B_M + F	71.66 a	564.19 b	4301.56 a	31.36 ns
Control	43.55 d	196.73 f	2287.34 d	30.54 ns

Dose of Nitrogen: 60 kg ha^{-1}

Treatments	Nos. of Capitula plant^{-1}	Seed Yield (kg ha^{-1})	Biomass Yield (kg ha^{-1})	Oil Content (%)
V_C	53.45 e	435.56 f	3184.45 c	31.17 ns
O_C	57.05 d	467.16 e	3373.59 c	32.00 ns
B_M	57.88 d	486.41 d	3033.23 c	31.40 ns
F	67.01 c	545.75 c	3840.523 b	31.39 ns
V_C + F	72.96 b	556.37 bc	4758.50 a	30.29 ns
O_C+ F	76.85 a	592.43 a	4774.10 a	30.15 ns
B_M + F	73.63 b	565.83 b	4500.02 a	30.27 ns
Control	45.23 f	198.14 g	2279.23 d	30.12 ns

For treatments in the same column followed by the same letter are not significantly different ($p<0.05$; Replication=3).

Number of capitula per plant showed a linear relation with seed yield. Maximum number of capitula were observed in combined application of oilcake and chemical nutrients at the higher nutrient level and it

was at per with the treatments of combination of vermicompost and bonemeal with chemical nutrients. Similar results were observed by Abdel-Sabour *et al.* (1999); Basha (2000); Ahmed (2001); Darwish *et al.* (2002); Aabou Youssef and EI-Eweddy (2003) who studied on the use of various organic and chemical nutrients and their combination for sunflower plants. Faiyad (1999) revealed that the effect of organic nutrients on plants gradually increases and this might be due to the slow nutrient releasing capability of them and thereby chelation of the essential elements by humic acid.

Significant increase in biomass yield of Niger could be marked on use of various nutrients irrespective of sources. Application of oilcake combined with chemical fertilizers provided highest biomass and seed yield among all other nutrient combinations. There are several evidences of proportionate increase in seed and biomass yield through application of various types and doses of compost (Abdel-Sabour *et al.* (1999)). Application of organic materials not only provides the soil with considerable amount of major plant nutrients like N, P and K but also add up appreciable amount of other trace elements. On the other hand, addition of N from organic sources in soil increases the fertility of soil and this in turn helps in higher crop production (Tahoun *et al.* 2000).

Addition of N from both organic and chemical sources had no significant effect on oil content in Niger seed under various treatment combinations. However, the treatment which provided highest yield (combination of oil cake with chemical nutrients) had lower amount of oil content in seed (Table 1). Zahoor *et al.* (2010) and Malik *et al.* (2001) stated similar result that N had a positive impact on Sunflower yield and higher levels of N gave increase in achene yield but had a negative impact on oil content.

Effect on Nitrogen Uptake

It is evident from Fig. 5 and 6 that the combined application of oilcake and chemical nutrient supersedes to all other treatments as far as Nitrogen uptake is concerned. This was followed by combined application of vermicompost and bonemeal with chemical nutrients. The high rate of N uptake by the crop may be attributed to high N content and low C/N ratio of oilcake which eventually led to its rapid decomposition in soil and thereby release of minerals. Addition of organic nutrients alone or in combination with chemical nutrients actually increases the chances of availability of N which otherwise leaches down through soil. This corroborates with the findings of Cordovil *et al.* (2001).

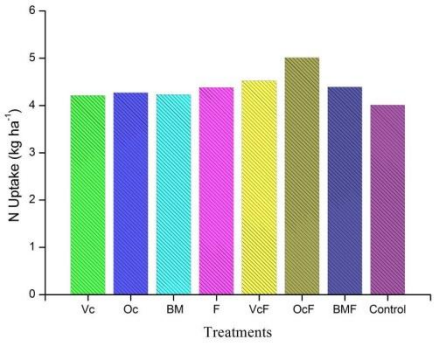

Fig. 5. Effect of Nitrogenous nutrients at the rate 30 kg ha^{-1}on Nitrogen uptake by Niger plant.

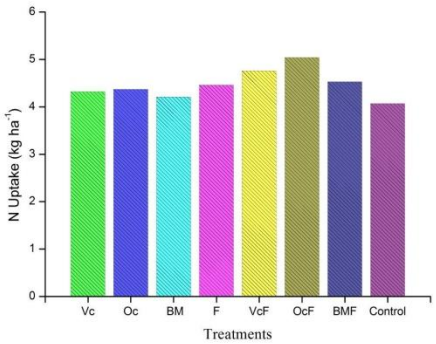

Fig. 6. Effect of Nitrogenous nutrients at the rate 60 kg ha^{-1}on Nitrogen uptake by Niger plant.

Effect on available Nitrogen after harvest

Nitrogen content (available N) in the soil after harvest was generally higher under combined application of organic and chemical nutrients compared to only chemical fertilizer and control treatments (Fig.7 and 8). However, maximum available N was found from combined application of oilcake and chemical nutrient.

This treatment provided maximum seed and biomass yield indicating the fact that availability of N played an important role in plant growth and yield.

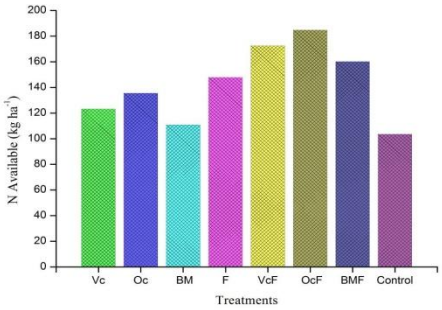

Fig. 7. Nitrogen available after harvest of Niger at supply of 30 kg ha^{-1} Nitrogen.

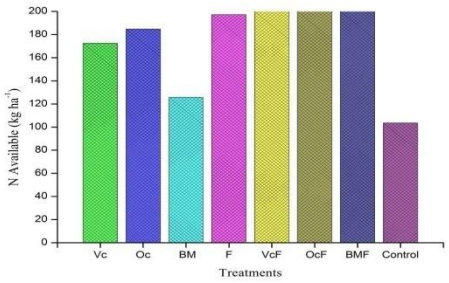

Fig. 8. Nitrogen available after harvest of Niger at supply of 60 kg ha^{-1} Nitrogen.

Conclusions

Plants treated with organic nutrients alone or in combination with chemical nutrients provided better result in all respects even though there was not much differences observed in two levels of Nitrogeneous nutrient. Oilcake combined with chemical nutrients provided the best result followed by vermicompost and bonemeal combined with chemical nutrients. Plots treated with organic nutrients alone also gave at per result with the yield of chemical fertilizer alone. It can be concluded that soil supplemented with organic nutrient combined with chemical fertilizer might be a good choice for increasing seed yield as well as soil quality improvement and lower dose of Nitrogen (30 kg ha^{-1}) can be used for improvement of Niger seed yield.

References

Abdel-Sabour MF, AboEl-Seoud MA, Rizk M. 1999. Physiological and chemical response of sunflower to previous organic waste composts application to sandy soils. Egyptian Journal of Soil Science **39,** 407-420.

Abou Youssef MF, El-Eweddy EA. 2003. Effect of tillage and nitrogen application regime on yield and nitrogen content of sunflower cultivated under calcareous soil conditions. Zagazig Journal of Agricultural Research **30,** 231-244.

Ahmed MKA. 2001. Effect of various fertilizers application on growth and yield of sunflower plants cultivated in sandy soils. Egyptian Journal of Applied Science **16,** 92-98.

Anonymous. 2001. The Nitrogen and acidity story. Agronomic acumen Newsletter Nov. 80.

Aracnon NQ, Edward CA, Bierman P, Metzeger GD. 2004. Influences of vermicomposts on field strawberries: Effects on growth and yields. Bioresour Technol **93,** 145-153.

Basha HA. 2000. Response of two sunflower cultivars to hill spacing and nitrogen fertilizer levels under sandy soil conditions. Zagazig Journal of Agricultural Research **27,** 617-633.

Chapman HD, Pratt PF. 1961. Methods of Analysis for Soils, Plants and Waters. Agric Publ University of California, Riverside.

Cordovil C, Cabral F, Rahn C, Fink M. 2001. Fertilizing value and mineralization of nitrogen from organic fertilizers (pot and incubation experiments). Proceedings of the International Conference on Environmental Problems Associated with Nitrogen Fertilization of Field Grown Vegetable Crops. Potsdam, Germany, 30 August to 1 September 1999. Acta Horticulture **563,** 139-145.

Darwish AA, El-Kabbany EAY, Mansour AFA, Dorgham EA. 2002. The influence of organic manure of Jojoba and/or castor bean residues on wheat plant. Egyptian Journal of Applied Science **17,** 376-389.

Dutta PC, Helmersson S, Kebedu E, Getine A, Appliqvist L. 1994. Variation in lipid composition of niger seed (*Guizotia abyssinica* Cass.) samples collected from different regions in Ethiopia. J Am Oil Chem Soc **71,** 839–843.

El Awag TL, Hanna AM, El-Naggar LM. 1996. Influence of mineral and organic nitrogen fertilization on wheat production and some soil physical properties. Journal of Agricultural Science (Mansoura University) **21,** 1491-1500.

El-Sherbieny AEA, Awad EAM, El-Sawy MMM, Helmy AM. 2003. Wheat response to some agro-industrial wastes and conventional N-fertilizers. Zagazig Journal of Agricultural Research **30,** 385-406.

Faiyad MN. 1999. Interaction effect between organic matter, iron and salinity on the growth and mineral content of wheat plants grown on recently reclaimed sandy soil. Zagazig Journal of Agricultural Research **26,** 1173-1189.

Gajendra G, Giri G. 2001. Effect of irrigation and nitrogen on performance of Indian mustard (*Brassica juncea*) and sunflower (*Helianthus annuus*) under two dates of sowing. Indian Journal of Agronomy **46,** 304-308.

Gomez KA, Gomez AA. 1984. Statistical Procedures for Agricultural Research. John Wiley & Sons, Singapore

Ibrahim ME, El-Absawy EA, Selim AH, Gaaffar NA. 2003. Effect of nitrogen and phosphorus fertilization levels on growth, photosynthetic, pigments, yield and yield components of some sunflower varieties (*Hilianthus annuus* L.). Zagazig Journal of Agricultural Research **30,** 1223-1271.

Malik MA, Shah SH, Mahmood S, Cheema MA. 2001. Effect of various planting geometries on the growth, seed yield and oil content of new sunflower hybrid (SF-187). Int J Agric Bio **3,** 55-56.

Melo JPL, De-Oliveira AP. 1999. Garlic production as a function of different water levels and bovine manure in soil. Horticultura Grasileira **17,** 11-15.

Nasim W, Ahmad A, Bano A, Usman M, Olatinwo R, Hammad HM, Khaliq T, Hussain M. 2012. Effect of N onyield and oil quality of sunflower (*Helianthus annuus* L.) hybrids under sub humid conditions of Pakistan. Amer JPlant Sci **03,** 243-251.

Nasim W, Ahmad A, Wajid A, Akhtar J, Muhammad D. 2011. Nitrogen effects on growth and development of sunflower hybrids uner agro-climatic conditions of Multan. Pak J Bot **43(4),** 2083-2092.

Nawar FRR, El-Kafoury AA. 2001. Effect of tillage system, plant spacing, farmyard manure and nitrogen fertilization on sunflower productivity in reclaimed land. Egyptian Journal of Applied Science **16,** 79-86.

Nel AA, Loubser HL, Hammes PS. 2000. The yield and processing quality of sunflower as affected by the amount and timing of nitrogen fertilizer. South Africa Journal of Plant and Soil **17,** 156-159.

Ramadan MF, Moersel JT. 2002a. Proximate neutral lipid composition of niger (*Guizotia abyssinica* Cass.) seed. Czech J Food Sci **20,** 98–104.

Ramadan MF, Moersel JT. 2002b. Direct isocratic normal-phase assay of fat-soluble vitamins and beta-carotene in oilseeds. Eur Food Res Technol **214,** 521–527.

Ramadan MF, Moersel JT. 2004. Oxidative stability of black cumin (*Nigella sativa* L.), coriander (*Coriandrum sativum* L.) and niger (*Guizotia abyssinica* Cass.) upon stripping. Eur J Lipid Sci Technol **106,** 35–43.

Ranganatha ARG. 2010. Improved Technology for maximizing production of Niger. Bulletin

Salehi F, Bahrani MJ. 2000. Sunflower summer-planting yield as affected by plant population and nitrogen application rates. Iran Journal of Agricultural Research **19,** 63-72.

Tahoun SA, Abdel-Bary EA, Atia NA. 2000. A greenhouse trial in view of organic farming in Egypt. Egyptian Journal of Soil Science **40,** 469-479.

Watson DJ. 1952. The physiological basis of variation in yield. Adv Agron **4,** 101-145.

Zahoor A, Riaz M, Ahmad S, Ali H, Khan MB, Javed K, Anjum MA, Zia-ul-Haq M, Khan MA. 2010. Ontogeny growth and radiation use efficiency of *Helianthus Annuus* L., as affected by hybrids, Nous regimes and planting geometry under irrigated arid conditions. Pak J Bot **42,** 3197-3207.