EFFECT OF NITROGEN FERTILIZER ON GROWTH AND FRUIT YIELD OF TWO OKRA (*Abelmoschus esculentus* L. Moench) VARIETIES

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ABSTRACT

Field work was conducted at the Teaching and Research Farm of the Federal University of Technology, Minna is located in the Southern Guinea Savanna ecological zone of Nigeria during the 2015 and 2016 cropping seasons. The experiment was laid out in a Randomized Complete Block Design and replicated three times. The treatments consisted of seven rates of nitrogen fertilizer (0, 20, 40, 60, 80, 100 and 120 kg N ha-1) and two okra varieties (NHAe47-4 and Clemson spineless). Plots were measuring 3×4 m ($12m^2$) comprising of five ridges. Parameters measured included days to first flower bud sighting and opening, days to 50% flowering, plant height, number of leaves, and stem girth at days to flower bud sighting and opening and days to 50% flowering, number of productive branches, flower abortion incidence, fresh fruit number/plot, fresh fruit girth and length/fruit, fresh fruit weight/plot, dry fruit girth and length/fruit, number of seeds/fruit and seed weight/fruit. Data were subjected to ANOVA and means separated by Duncan Multiple Range Test (DMRT) at 5% level of probability. Application of 80 and 100 kg N ha^{-1} resulted to the highest growth and yield parameters amongst all the nitrogen treatments in the both years. Therefore application of 80 kg N ha^{-1} should be adopted by farmers in the study area to maximize their yield. NHAe47-4 is recommended for immature fruit and seed production, Clemson spineless is also recommended for high productivity but Clemson spineless fruits contain more number of seeds than NHAe47-4 variety.

Keywords: Okra, nitrogen fertilizer, yield

INTRODUCTION

Okra is one of the most widely known and utilized species of the family Malvaceae (Naveed *et al.*, 2009) and an economically important vegetable crop grown in tropical and sub-tropical parts of the world (Saifullah *et al.*, 2009). Okra grows best on well-drained sandy loam soil; it prefers slightly acidic soils with a pH between 5.8 and 6.5 (Department of Agriculture, Forestry and Fisheries, 2012). The minimum and maximum soil temperatures for growth are 18 and 35 °C respectively and relative humidity of 21 – 30% (Ezeakunne, 2004). The nutritional composition of okra includes calcium, protein, oil and carbohydrates, iron, magnesium and phosphorus (Omotoso and Shittu, 2007). Okra, which is currently grown mainly as a vegetable crop, has potential for cultivation as an essential oilseed crop because okra seeds contain high amount of oil (20-40%) (Sorapong, 2012).

Fertilizer affects the quality and productivity of soils and crops. Weak vegetative growth, poor fruit setting, undesirable fruit yield and consequent low seed yield result from inadequate levels of the primary soil nutrients namely: Nitrogen (N), Phosphorus (P) and Potassium (K) (Liu *et al.*, 2010). Unfortunately these primary soil nutrients (NPK) are the three major fertilizer elements known to be deficient in most Nigerian soils due to intense pressure on land as a result of continuous cropping. Nitrogen is one of the major nutrients of importance in the vegetative growth and yield of okra plants. The crop has high affinity for nitrogen; as it plays a significant role in many of the metabolic processes such as cell division and chlorophyll formation that is responsible for photosynthesis (Muhammad *et al.*, 2013). Olaniyi (2007) recommended adequate supply of nitrogen for vigorous vegetative growth, optimum fruit yield and good seed formation in okra plants. According to Firoz (2009) nitrogen is an essential nutrient for plant growth and is a key limiting factor in agro ecosystems. Lawlor (2002) and Ulukan (2008) reported that vigorous growth is greatly affected by Nitrogen and the response is more pronounced under increasing Nitrogen supply. Several works have reported linear increase in green fruit yield of okra with the application of N from 56 to 150 kg ha^{-1} (Majanbu *et al.*, 1985 and Singh, 1995). Nutrition of the mother-plant is also known to influence the yield of seed in crop plants. Rathke *et al.* (2005) also reported that application of nitrogen fertilizer increased the seed yield of winter oilseed rape.

There is little information in respect of N requirement for okra production, several studies reported that okra growers are only interested in fruit yield with no attention to quality seed production (Sajid *et al.*, 2012). Synthetic fertilizers have been used by researchers to obtain very encouraging results in yields and nutritional quality of okra fruits over the years. The objectives of the study were to determine the effect of nitrogen fertilizer rates for optimum plant growth, fruit yield, seed yield and good quality of two okra varieties.

MATERIALS AND METHODS

Field experiment was conducted at the Teaching and Research Farm of the Federal University of Technology, Minna (Minna (latitude 9^0 51 ^{1}N and longitude 6^0 44 ^{1}E) during the 2015 and 2016 cropping seasons (May-Sept). Soils in Minna originated from basement complex rocks and generally are classified as Alfisols (Lawal *et al.*, 2012). Before land preparation, Soil samples were collected from surface (0-15cm) with an auger from 10 points along four diagonal transects, each bulked together to give four composite samples. The soil samples were air dried and sieved through 2mm and 0.5mm sieve. They were analyzed for particle size distribution, pH 1:2 (H_2O and $CaCl_2$). Organic carbon, total nitrogen, available phosphorus, exchangeable bases (Ca^{2+}, Mg^{2+}, K^+, Na^+), exchangeable acidity (Al^{3+} + H^+) and effective cation exchange capacity following the procedures as described by Agbenin

(1995). Seeds of NHAe47-4 variety of okra were sourced from the National Horticultural Research Institute (NIHORT) substation, Bagauda Kano, Nigeria, and Clemson Spineless variety was sourced from Premier Seed Company, Zaria, Nigeria.

The land was manually cleared and ploughed with a tractor and ridges were constructed manually at 75 cm apart each measuring 3 m long. Plots were measuring 3×4 m ($12m^2$) comprising of five ridges. The treatments were a factorial combination of two okra varieties (NHAe47-4 and Clemson spineless) and seven N levels, (0, 20, 40, 60, 80, 100, 120 kg ha^{-1}), laid out in Randomized Complete Block Design (RCBD) with three replications. Three seeds were manually sown per hole at 0.5m apart and later thinned to one seedling per stand (2WAP). Phosphorus and K fertilizer at 50 kg ha^{-1} each was applied in all the plots 2 week after planting (WAP), as Basal application using single super phosphate and muriate of potash as sources. N application was split using urea as a source. The first application was 2WAP and second application was 4 WAP (before flowering). Weeding was carried out at two weeks intervals manually. Incidence of insect pests was kept down with the application of Zap® a.i (Lambda Cyhalothrin 25g/L), at 0.005kg a.i/ha. Insecticide was applied as from 2WAS till harvesting stage.

The parameters measured/recorded includes: Days to first flower bud sight which was recorded by counting the number of days from sowing to the first flower bud sight, days to first flower opening was recorded by counting the number of days from sowing to the first flower opening, days to 50% flowering was recorded by counting the number of days from sowing to when half of the plant population would have flowered. Plant height were measured from the base of the plant to the tip of the last leaf, using a meter rule at first flower bud sight, first flower opening, 50% flowering and at maturity. Number of leaves was recorded by counting the number of leaves on the plant at first flower bud sight, first flower opening, 50% flowering and at maturity. Stem girth was measured by measuring the stem 5cm from the base of the plant with the use of verneir caliper at first flower bud sight, first flower opening, 50% flowering and at maturity. Number of productive branches at maturity was recorded by counting the number of branches that produced fruit from the plant at maturity. Flower abortion incidence at maturity was recorded by counting the number of flowers that fall after formation (opening). The number of fresh fruits was recorded by counting the fruits harvested/plot; weight was determined by using electronic weighing balance, during harvest per plant/plot. Fruit diameter was also determined by measuring the fruit with the use of a caliper and Fruit length was determined by using a meter rule at harvest. Dry fruit/plant/plot was determined by measuring fruit girth and length, counting the number of seeds and weight of dry seed. The data collected were subjected to analysis of variance (ANOVA) using SAS Statistical package 9.2. At 5% level of probability means were separated using Duncan Multiple Range Test.

RESULTS

The results of some physical and chemical properties before land preparation for the experimental field in 2015 season are shown in Table 1. The particle size analysis showed the soil of the site to be loamy sand in texture with a moderate pH indicating the soil is slightly acidic in reaction. Soil organic carbon (SOC) was low with moderate contents of total soil nitrogen and available phosphorus and ECEC of the soil was also found to be low.

Table 2 shows the effect of nitrogen fertilization on days to first flower bud sighting, days to first flower bud opening and days to 50% flowering. Effects of variety on this trait was not significant ($p>0.05$) in both 2015 and 2016 cropping seasons. In both years, application of 100/120 kg ha^{-1} of nitrogen significantly delayed flower bud initiation, flower bud opening and attainment of 50% flowering compared to plants that received lower rates (0 to 80 kg N ha^{-1}) of nitrogen. The effect variety and rates of nitrogen fertilization on plant height of two okra cultivars at different stages of growth in 2015 and 2016 cropping season are presented in (Table 3). The result showed that variety did not significantly affect plant height at first flower bud sighting in 2015. The difference was however significant in 2016 with Clemson spineless growing taller (19 cm) than NHAe47-4 (18cm). Increasing levels of nitrogen also increased the height of plants at flower bud appearances and opening significantly in both cropping seasons. Application of 100 to 120 kg ha^{-1} of nitrogen generally resulted in the production of significantly taller plants at all the stages of plant growth.

Table 4 shows that the effect of nitrogen fertilization on the number of leaves/plant of two okra cultivars at different stages of growth. Effect of variety on this trait was not significant at all the stages of plant growth. Though application of 100 kg ha^{-1} yielded more leaves (8) per plant, this value was statistically similar with values produced when 60 – 100 kg n ha^{-1} was applied in 2015 and 2016 cropping seasons. Generally application of 80 to 120 kg n ha^{-1} to plants of the two cultivars influenced the performance in all the traits assessed. The effect of variety on productive branches per plant and flower abortion incidence were not significant in the two cropping seasons. Application of any of the rates of nitrogen generally resulted in the production of between 3 and 5 branches. These values are statically similar (Table 5). Flower abortion decreased with increases in the rate of nitrogen application. Significantly fewer (2) flower abortion was recorded when 80 to 100 kg ha^{-1} of nitrogen was applied to plants in both cropping seasons. Effect of variety was not significant on number of fresh fruits per plot. Fresh fruit girth was however significantly affected with NHAe47-4 producing bigger fruits than those of clemson spineless (Table 6). Fruits of Clemson spineless on the other hand are longer than those of NHAe47-4. The total fruit yield by weight of the two cultivars per plot *was* statistically similar in the two cropping seasons.

DISCUSSION

The delay in flower bud sighting, subsequent opening and days to 50% flowering recorded during growth of okra plants of the two varieties that were fertilized with higher rates of nitrogen especially at 100 to 120 kg N ha^{-1} in this study is an indication that nitrogen at those rates was surplus. Amjad *et al.* (2001) cautioned against the use of extra nitrogen on vigorous plants as the practice may result in plants producing heavy foliage which will delay flowering and will eventually translate to poor fruit yield. Khan *et al.* (2000) reported that higher rates of nitrogen resulted in significant delay in flowering and fruiting of egg plant compared to plants of the control and 50 – 80 kg N ha^{-1}.

The significantly taller plants, higher leaf number and higher fruits number per plot produced with the application of 100/120 kg nitrogen per hectare at all the stages of plant growth in this study may be linked to mobility of nitrogen known for inorganic sources of nitrogen fertilizers. Nitrogen from inorganic fertilizers is readily available at early stages of plant growth. Nitrogen from such sources is readily depleted through rapid crop removal, leaching and/or denitrification. This can retard the growth of plants with age. Higher rates of nitrogen coupled with split application ensures the supply of nitrogen nutrient at all the stages of plant growth. This might have guaranteed the consistence in plant growth over time which might have conferred the superiority in height at all the growth stages in this study. These results are supported by the reports of Nanthakumar and Veeraragavathatham (2001) in brinjal and Firoz (2009) in tomato. Sarnaik *et al.* (1986) have also reported that the beneficial effect of zero and 20 – 40 Kg ha^{-1} nitrogen rates on three cultivars of 'yakuwa' (rossel) was short-lived compared to higher rates of 60 – 100 Kg n ha^{-1}. Majanbu *et al.* (1985) also observed that plant height was enhanced by application of 100 kg N ha^{-1}. Lawlor (2002) reported that leaf number is substantially increased by increasing N levels. John *et al.* (2004) reported that N fertilization vigorously enhances leaf production in okra than zero N application. Similarly, Babatola (2006) reported that application of 80kg N ha^{-1}enhanced yield parameters of okra plant. Optimal use of N at 60-100 kg ha^{-1} improves fruit yield over the lower rates of 20 – 40 kg N ha^{-1} Yih-Chi Tan *et al.* (2009) indicated that nitrogen rate of 50-80 kg N ha^{-1} significantly increased the yield of the green pod per plant of okra compared to lower rates of the same nutrient.

CONCLUSION

It is concluded from this study that flowering was significantly delayed when higher nitrogen rates (80-120 kg N ha^{-1}) were applied to plants. However, all the traits studied increased significantly with increase in nitrogen rates. Application of nitrogen at 80 – 100 kg ha^{-1} to okra plants enhanced growth and fruit yield compared to all other N rates. Plants to which no fertilizer was applied performed poorly in respect of all parameters studied.

Table 1: Physiochemical properties of the surface soil sample (0-15cm) from the study site before fertilizer application

Soil Properties	Values
Particle Size distribution ($g\ kg^{-1}$)	
Sand	812.5
Silt	110
Clay	77.5
Textural class	LS
pH (1:2)	
H_2O	6.6
KCl or CaCl	5.45
Total N ($g\ kg^{-1}$)	1.23
Organic C ($g\ kg^{-1}$)	4.5
Available P ($mg\ kg^{-1}$)	8.25
Exchangeable bases ($C\ mol\ kg^{-1}$)	
Ca^{2+}	3.75
Mg^{2+}	3
K^{+}	0.07
Na^{+}	0.17
Exchangeable acidity ($C\ mol\ kg^{-1}$)	
Al3+ H+	0.7
ECEC	8.1

LS: Loamy sand

Table 2: Effect of nitrogen fertilization on days to first flower bud sighting, days to first flower bud opening and days to 50% flowering

	Days to first flower bud sight		Days to first flower bud opening		Days to 50% flowering	
Treatments	2015	2016	2015	2016	2015	2016
Variety						
NHAE47-4	39a	40a	51a	52a	68a	68a
Clemson spineless	39a	40a	52a	52a	68a	69a
± SE	0.2	0.2	0.2	0.1	0.3	0.3
N rate kg/ha						
0	33e	33f	46e	47f	61f	62e
20	35d	35e	47d	48e	63f	62e
40	36d	38d	49d	48e	65e	67d
60	39c	40c	51c	52d	67d	67c
80	42b	43b	52c	53c	71c	73b
100	45a	46a	56b	58b	73b	75a
120	44a	45a	57a	59a	76a	76a
± SE	0.3	0.3	0.3	0.3	0.5	0.5
Interaction						
V*F	NS	NS	NS	NS	NS	NS

Means followed by the same letter(s) in a column for the same factor are not significantly different at $P \leq 0.05$

Table3: Effect of nitrogen fertilization on the plant height of two okra varieties at different stages of growth.

Treatments	Stages of plant growth							
	First flower bud sight		First flower bud opening		50% flowering		At Maturity	
	2015	2016	2015	2016	2015	2016	2015	2016
Variety								
NHAE47-4	15a	18b	18a	52a	52a	58a	60a	73a
Clemson spineless	15a	19a	19a	51a	52a	59a	60a	71a
± SE	0.05	0.1	0.1	0.5	0.5	0.3	0.3	0.5
N rate kg/ha								
0	13g	15d	16d	40d	39d	35f	42f	37f
20	14f	17c	18c	46c	45c	52e	53e	62e
40	14e	18b	18bc	48c	48c	53d	55d	68d
60	15d	19b	19b	48c	49c	61c	62c	82b
80	16c	19b	20b	53b	54b	67b	68b	90a
100	17b	21a	21a	66a	66a	72a	74a	88a
120	17a	21a	21a	63a	64ab	70a	72a	78c
± SE	0.09	0.2	0.2	0.1	0.1	0.6	0.5	0.9
Interaction								
V*F	NS	NS	NS	NS	NS	NS	NS	NS

Means followed by the same letter(s) in a column for the same factor are not significantly different at P≤0.05

Table 4: Effect of nitrogen fertilization on the number of leaves/plant of two okra varieties at different stages of growth

Treatments	Stages of plant growth							
	First flower bud sight		First flower bud opening		50% flowering		At Maturity	
	2015	2016	2015	2016	2015	2016	2015	2016
Variety								
NHAE47-4	5a	7a	11a	10a	18a	16a	20a	21a
Clemson spineless	5a	6a	10a	9a	17a	15a	21a	20a
± SE	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.5
N rate kg/ha								
0	4c	5c	7d	8e	13d	11d	15e	13f
20	5bc	6bc	8d	8de	15c	12d	19d	14e
40	5bc	7bc	9c	8cd	16b	14c	20cd	14e
60	6abc	8abc	10ab	10bc	16b	16b	21c	15d
80	6abc	9a	11ab	10ab	19a	16b	22ab	16c
100	8a	9a	12a	11a	19a	17a	23a	21a
120	6bc	6bc	12a	10a	19a	17a	24a	20b
± SE	0.1	0.1	0.2	0.2	0.2	0.4	0.4	0.1
Interaction								
V*F	NS	NS	NS	NS	NS	NS	NS	NS

Means followed by the same letter(s) in a column for the same factor are not significantly different at P≤0.05

Table 5: Effect of nitrogen fertilization on productive branches and flower abortion incidence

Treatments	Number of productive branches/plant 2015	Number of productive branches/plant 2016	Flower abortion incidence/plant 2015	Flower abortion incidence/plant 2016
Variety				
NHAE47-4	3a	4a	3a	3a
Clemson spineless	3a	3a	3a	3a
± SE	0.2	0.1	0.1	0.1
N rate kg/ha				
0	2a	2b	4a	5a
20	2a	3b	3b	3b
40	3a	4a	3b	4b
60	3a	4a	3b	3b
80	4a	5a	2c	2c
100	4a	5a	2c	2c
120	3a	3b	3b	3b
± SE	0.3	0.2	0.2	0.2
Interaction				
V*F	NS	NS	NS	NS

Means followed by the same letter(s) in a column for the same Factor are not significantly different at P ≤ 0.05

Table 6: Effect of nitrogen fertilization on number of fresh fruit/plot, fresh fruit girth/plant, fresh fruit length/plant and fresh fruit weight/plot

Treatments	Number of fresh fruits/plot 2015	Number of fresh fruits/plot 2016	Fresh fruit girth (cm) 2015	Fresh fruit girth (cm) 2016	Fresh fruit length (cm) 2015	Fresh fruit length (cm) 2016	Fresh fruit weight/plot (g) 2015	Fresh fruit weight/plot (g) 2016
Variety								
NHAE47-4	35a	37a	12.7a	12.4a	10.6b	10.4b	738.8a	737.3a
Clemson spineless	34a	36a	11.2b	11.4b	11.3a	11.0a	758.4a	739.6a
± SE	0.4	0.4	0.1	0.09	0.05	0.07	16.3	15.4
N rate kg/ha								
0	24f	23e	10.8d	9.1f	9.8d	8.1e	525.2e	424.2e
20	30e	32d	10.9d	10.1e	10.4c	9.5d	614.7d	620.3d
40	35d	38c	11.8c	11.5d	10.5c	10.3c	684.3cd	690.4cd
60	37c	39c	12.2bc	12.7c	11.0b	11.2b	725.5bc	730.2c
80	38b	41b	12.7ab	13.2ab	11.6a	11.8a	797.8b	818.1b
100	41a	46a	13.1a	13.7a	11.8a	12.0a	933.7a	969.6a
120	41a	42b	12.5abc	12.9bc	11.8a	11.9a	959.4a	937.4a
± SE	0.7	0.81	0.2	0.17	0.1	0.1	30.5	28.9
Interaction								
V*F	NS	**	NS	*	NS	*	NS	*

Means followed by the same letter(s) in a column for the same factor are not significantly different at P≤0.05

REFERENCES

Agbenin, J. O. (1995). Laboratory manual for Soil and Plant Analysis. (Selected Method and Data Analysis). Published by Agbenin. 140pp.

Akanbi, W. B., Akande, M. O. and Adediran, J. A. (2005). Suitability of composted maize straw and mineral nitrogen fertilizer for tomato production. *Journal of vegetable Science,* 11 (1), 57-65.

Amjad, M., Anjum, M. A. and Ali, A. (2001). Effect of phosphorus and planting density on seed production in okra. *International journal of Agriculture and Biology, pp,* 380-383.

Babatola, L. A. (2006). Effect of NPK 15:15:15 on the performance and storage life of okra (*Abelmoschus esculentus*). *Proceedings of the Horticultural Society of Nigeria Conference,* pp.125-128.

Department of Agriculture, Forestry and Fisheries. (2012).

Ezeakunne, C. O. (2004). Large scale fruit and vegetable production in Nigeria. *Extension Bulletin,* NAERLS, ABU, Zaria, 8, 6-8.

Firoz, Z. A. (2009) Impact of nitrogen and phosphorus on the growth and yield of okra *[Abelmoschus esculentus* (L.) Moench] in hill slope condition. *Bangladesh Journal of Agriculture Research.* 34(4), 713-722.

John, L. W., Jamer, D. B., Samuel, L. T. and Warner, L. W. (2004). Soil Fertility and Fertilizers: An Introduction to Nutrient Management. Pearson Education, India, 106-153.

Khan, H. M., Khan, K., Rasul, A., Majeed, A. and Safi, F. A. (2000). Effect of different levels of nitrogen alone and in combination with constant doses of phosphorus and potassium on growth and yield of okra (*Abelmoschus esculentus* L.) Cv. T-13 under agro-climatic conditions of Mingora, Swat. *Pakistan Journal of Biological Science,* 3(12), 2101-2104.

Lawlor, D. W. (2002). Carbon and nitrogen assimilation in relation to yield: Mechanisms are the key to understanding production systems. *Journal of Experimental Botany* 53, 773-787.

Lawal, B. A, Adeboye, M. K. A., Tsado, P. A., Elebiyo, M. G. and Nwajoku, C. R. (2012). Properties, classification and agricultural potentials of lateritic soils of minna in sub-humid agroecological zone, Nigeria. *International Journal of Development & Sustainability,* 1(3), 903-911.

Majanbu, I. S. Ogunlela, J. D., and Ahmed, M. K. (1985). Response of two okra (*Abelmoschus esculentus L.* Moench) varieties to fertilizer yield and yield component as influenced by nitrogen and phosphorus application. *Fertilizer Research,* 6,257 267.http://dx.doi.org/10.1007/BF01048799

Muhammad, A. K., Muhammad, S., Zahid, H., Abdur, R., Khan, B., Marwat, F. and Shahida, B. (2013). How nitrogen and phosphorus influence the phenology of okra. *Pakistan Journal of Botany, 45*(2), 479-482.

Nanthakumar, S. and Veeraragavathatham, D. (2001). Effect of integrated nutrient management on yield and quality attributes of brinjal cv "*Plr*". *Southern Indian Journal of Horticulture,* 49, 195-198.

Naveed, A., Khan, A. A. and Khan, I. A. (2009). Generation mean analysis of water stress tolerance in okra (*Abelmoschus esculentus* L.). *Pakistan Journal Botany,* 41, 195-205.

Olaniyi, J. O. (2007). Propagation of Horticultural crops. *Iyanda Bindery and printing press,* Ogbomoso, Nigeria.

Rathke, G. W., Christen, O. and Diepenbrock, W. (2005). Effects of nitrogen source and rate on productivity and quality of winter oilseed rape (*Brassica napus L.*) grown in different crop rotations. *Field Crops Research,* 94 (2–3), 103–113.

Saifullah, M. and Rabbani, M. G. (2009). Evaluation and characterization of okra (*Abelmoschus esculentus* L. Moench.) genotypes. *Journal of Agriculture* 7: 92-99.

Sajid, M., Khan, M. A., Rab, A., Shah, S. N. M., Arif, M., Jan, I., Hussain, Z. and Mukhtiar, M. (2012). Impact of nitrogen and phosphorus on seed yield and yield components of okra cultivars. *Journal of Animal and Plant Sciences,* 22(3), 704-707.

Sarnaik, D. A., Bagael, B. S. and Singh, K. (1986). Response of Okra seed crop to major nutrients. *Research and Development Reporter,* 3(2), 1012.

Singh, I. P. (1995). Effect of various doses of nitrogen on seed yield and quality of okra (*Abelmoschus esculentus* (L) Moench). *Annals of Agril. Res., 16*(2), 227-229.

Sorapong, B. (2012). Okra (*Abelmoschus esculentus* (L.) Moench) as a Valuable Vegetable of the World. *Ratar. Povrt.,* 49,105-112.

Ulukan, H. (2008). Agronomic adaptation of some field crops: A general approach. *Journal of Agronomy and Crop Science,* 194, 169-179.

Yih-Chi, T., Jihn-Sung Lai, K. R., Adhikari, S. M., Shakya, A. K., Shukla, A. K. and Sharma, K. R. (2009). Efficacy of mulching, irrigation and nitrogen applications on bottle gourd and okra for yield improvement and crop diversification. *Irrigation Drainage System,* 23, 25.