Research Journal of Agronomy 1 (3): 99-104, 2007
ISSN: 1815-9354

Influence of Source and Time of Nitrogen Application on Growth, Yield and Nutrient Composition of Egusi Melon

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Abstract: 'Egusi' melon is an important seed vegetable crop in Nigeria. There is scanty information on its cultural practice requirements for optimum seed yield. Field studies were conducted during the early and late seasons of 2002 on an affisol to determine the appropriate source and time for N fertilizer application and to identify the appropriate index leaf for N diagnosis. One 'egusi' melon cultivar, Black – edged seed 'bara' and two N sources [urea and Calcium Ammonium Nitrate (CAN)] at 0 and 60kg.N ha^{-1} were investigated. The N fertilizers were applied at five different growth stages as split or single dose. The 2×5 factorial treatment combinations were arranged in a randomized complete block design and replicated thrice. 'Egusi' melon growth parameters, seed yield and nutrient contents in different leaf positions were assessed. Data obtained were analyzed using ANOVA. Split application of N fertilizer significantly ($p \leq 0.05$) improved 'egusi' melon growth and seed yield compared to single dose. Split application of N as half dose at planting and remaining half at vine initiation gave highest melon seed yield. Urea as a source of N fertilizer was found to show an outstanding performance in both seasons, irrespective of the time of N application compare to CAN. The 5th and 6th leaf positions recorded the highest nutrients concentration. Based on the high nutrient contents of the 5th and 6th leaves, they could serve as an indicator of yield and therefore, be used as index leaf.

Key words: 'Egusi' melon, N source, time of N application, seed yield, nutrient contents, leaf positions, index leaf

INTRODUCTION

The Cucurbitaceae consists of nearly 100 genera and over 750 species. Although most have Old World origins (Whistaker and Davis, 1962). Many species originated in the New World and at least seven genera have origins in both hemispheres (Esquinas-Alcazar and Gulick, 1983). 'Egusi' melon (*Citrullus lanatus* (Thunb) Mansf.) originated from the Old World and one of the underexploited tropical crops.

A relative of watermelon, 'egusi' melon is native to tropical Africa and highly drought tolerant. Productivity is enchanced during dry, sunny period and reduced during periods of excessive rainfall and high humidity. It is suitable for production in "marginal growing areas". The fruits are extremely bitter, but the seeds can be removed and roasted as an edible commodity (Soliman *et al.,* 1985; Ng, 1993; Olaniyi, 2006). The seeds are rich in oils, which can be extracted for cooking purposes and the seeds can also be ground into a powder and used as a soup thickener or flavoring agent (Badifu and Ogunsua, 1991).

Soils of tropical regions vary greatly in their contents of organic matter and total nitrogen. The practice of bush burning, non- incorporation of plant residues into the soils and continuous cultivation without leguminous arable crops, rapidly depletes the soil nitrogen. Incorporation of undecomposed plant residues with very wide C:N ratio results in temporary immobilization of available nitrogen (FPDD, 1991).

It has been shown that soil organic matter correlates well with total nitrogen. Balasubramanian and Nnadi (1977) reported that the levels of many nutrients in savanna soils are intrinsically tied to the level of organic matter in these soils. This is particularly true of nitrogen, phosphorus and sulphur. Balasubramanian *et al.* (1981) found that while the organic carbon contents of the soils ranged from 0.231% in the sudan savanna zone of total nitrogen varied from 0.014-0.920%. Generally, savanna soils have lower N status and wider C/N ratio

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than forest soil which greatly affect N availability. Nye (1951) found acute shortage of available N in land which have been left under fallow for ten years or more in savanna zone and crops responded well to applied N.

Nitrogen is a key element for food crop production in the savanna. Vegetative growth most often is directly related to the amount of N available to the crop (added or inherent). With the low level of mineralizable N in Savanna soils, due largely to the low organic mater content, leaching, denitrification and volatilization, N deficiencies occur in crop plants. Nitrogen deficiency in melon as been identified as yellow green to yellow leaves in more severe cases; slender, hard and fibrous stems; stunted, brown and dead roots and fruits may be poorly netted and sunburned due to lack of foliar cover (Gorski, 1985). The use of inorganic fertilizer supplements are therefore required for any reasonable crop yields to be obtained. Generally, responses are often high even in the first year after prolonged fallow periods (Jones and Wild, 1975).

Maximizing the efficiency of N fertilizers entails identifying the most suitable N source for the soil and crop under test. In the fragile soils of the Nigerian Savanna, this can be a very important factor. Urea and calcium ammonium nitrate and some compound fertilizer formulations are in common use in this zone. Ammonium sulphate, highly favoured in older trials is no longer recommended because of its high acidifying property (Jones, 1974). Comparative studies of the different N sources in savanna zone have demonstrated little differences among them in terms of their immediate N supplying power and crop yield responses (Balasubramanian and Singh, 1982; IFDC, 1985). Any evaluation of N sources must therefore take into account their deleterious effects on other soil chemical properties and also their cost.

Studies conducted at Samaru and Mokwa, Nigeria, showed that although urea and Calcium Ammonium Nitrate (CAN) produced less acidity than ammonium sulphate, the acidity produced by these two fertilizers was still significant. The rate of acidification increased as the N rate increased, an effect that was more pronounced with ammonium sulfate (Jones, 1976). Urea seems to have an edge over CAN and urea Supergranules (SUG) for its high analysis and less problematic method of application. Soil analysis results showed that NO_3-N content of soils did not vary with N source and was higher at the surface 15cm than of greater depths. CAN appeared to depress pH most slowly while urea did so most quickly (IFDC, 1985). Available information (Olaniyi, 2006; Gorski, 1985) does not discuss the effects source and time of applied N play on the performance of 'egusi' melon. This investigation was undertaken to determine how N source and time of application affected the growth, yield and nutrient competitions, as well as determining index leaf for N diagnosis.

MATERIALS AND METHODS

Field experiments were conducted during the early and late seasons of 2002, on an Alfisol at the Teaching and Research, Ladoke Akintola University of Technology (LAUTECH), Ogbomoso , Nigeria. Ogbomoso is located at longitude 4°10'S and latitude 8°10'N in the Guinea Savanna Zone of Southwestern Nigeria. Rainfall distribution is bimodal over eight or nine months of the year. The mean monthly temperature, relative humidity and rainfall pattern in Ogbomoso (Olaniyi, 2006) are within the range considered suitable for melon by Gorski (1985).

One 'egusi' melon cultivar, Black-edged seed 'bara' which showed outstanding performance in Ogbomoso, southwest Nigeria; and two N sources (urea and Calcium Ammonium Nitrate (CAN)) at two N rates, 0 and 60 kg.N ha^{-1} which represented a control and the best N rate, were investigated during the early and late seasons of 2002.

N fertilizer was applied either as single dose or as split at five different growth stages:

T_1 = Entire dose at sowing.
T_2 = Entire dose at vine initiation [30 DAS].
T_3 = Entire dose at 50% flowering [60 DAS].
T_4 = 50% dose at planting and 50% dose at vine initiation.
T_5 = 50% dose at planting, 25% dose at vine initiation and 25% dose at 50% flowering.

This gave a 2×5 factorial experiment, giving a total of 10 treatments which were arranged in a randomized complete block design with 3 replicates. Each plot was 12×6 m with 5 rows of melon plants grown at 1×1 m spacing. At planting 3 seeds were sown in each hole and seedlings were thinned down to one plant per stand 2 weeks after sowing to give a population of 10,000 plants ha^{-1}. Basal application of 8.8kg P + 16.6 kg K ha^{-1} was applied at planting. N fertilizers were applied by side banding method to the crops at their respective rates and time of application three weeks after sowing.

Weeds were controlled by hoeing at 3 and 6 WAS. Insect pests and diseases were controlled by application of Ambush and Benlate at a rate of 500 g.ha^{-1} a.i., at 4 and 7 WAS, against fruit flies and anthracnose, respectively. Destructive sampling collected data from 6 plants randomly chosen plants/plot. Vine length was determined by measuring the primary vine, counting numbers of

Table 1: Growth parameters of 'egusi' melon as affected by source and time of N application in the early and late seasons of 2002 at 10 WAS

	Season							
	Vine Length (cm)		Number of Vine		Number of leaves		Dry matter yield (g plant^{-1})	
Time and level of N (Kg ha^{-1})	Early	Late	Early	Late	Early	Late	Early	Late
N_0T_0	195	186.4	22	25	239	235	95	65.7
N_1T_1	240.4	221.5	42.1	36.5	420.5	286.5	120	85
N_1T_2	285.2	262.8	50.5	50.2	500	405	140.2	115.3
N_1T_3	270.6	250.5	55.7	42	351.6	312	122.5	98
N_1T_4	305.8	285	66.6	60.5	552.2	465.5	155	133.3
N_1T_5	290.5	269.7	62.4	56	506.5	410.1	145.6	124
Mean	264.6	245.9	49.7	45	428.3	352.4	129.7	103.6
N_0T_0	191.5	188.2	20.7	25.2	240.5	233.3	94	66
N_2T_1	225.7	216	36	31.1	385.5	270	101.7	79.2
N_2T_2	278	256.5	46.6	45.8	451.5	365.5	125.5	102.5
N_2T_3	265.5	235.5	51	36.5	308.2	298.5	105	82.5
N_2T_4	292	267.7	62	52	513.2	425	135.8	126.7
N_2T_5	281.3	251	55.2	48.5	467.4	381.4	130	119.5
Mean	306.7	191.2	45.3	39.8	394.4	328.9	115.3	96.1
LSD(0.05):								
Source(S)	33.5	59.3	3	19.07	132.07	108.31	49.66	42.21
Time (T)	6.8	12.1	14.82	3.86	26.71	21.9	10.04	8.54
SXT	6.8	12.1	14.82	3.86	26.71	21.9	10.04	8.54

S = N source, N_1 = Urea fertilizer, N_2 = CAN fertilizer, T = Time of N application, T_0 = Control, LSD (0.05) = Least Significant Difference

leaves and dry matter yield determined at three different sampling periods by drying the whole plant at 65°C for 48 h and weighed. The sampling periods were) at vine initiation (4 WAS) at flowering (7 WAS) and) at fruit formation (10 WAS). Days to 50% flowering, numbers of male and female flowers, number and weight of fruit, number of seed/fruit, number and weight of seed on a plant and hectare bases were used to determine yield.

Four different leaf numbers namely, the 5, 6, 7 and 8th leaves were sampled separately (Gorski, 1985), from the fully-expanded leaves from top of the primary vine of 20 plants at 7 WAS (at flowering) for nutrients content determination. These were dried to constant weight at 65°C for 48 h, milled and analyzed for total N, P, K, Mg and Ca total nitrogen content in leaves was separately determined by the Micro-kjeldahl method (Tel and Hagarty, 1984). Other minerals P, K, Mg and Ca were also determined separately by AOAC method (AOAC, 1990).

The data collected were analyzed statistically using SAS-GLM procedure (SAS, 1989) for Analysis of Variance (ANOVA). Differences among treatment means were compared where applicable, using the Least Significant Difference (LSD) at 0.05 probability level.

RESULTS

Growth parameters: The average vine length, number of vines, number of leaves and dry matter yield considered from one sampling occasions to another (4 and 7 WAS data not shown) significantly increased with the highest values recorded at 10 WAS during the two seasons (Table 1). In both seasons, most of these parameters were significantly ($p \leq 0.05$) affected by the N sources at 10 WAS. High values of vine length, number of vines, number of leaves and dry matter yield were obtained for Urea fertilizer while CAN gave the least values. The time of N fertilizer applications irrespective of sources significantly ($p \leq 0.05$) increased all the growth parameters at all the sampling occasions during the two seasons. The highest values for all the growth parameters considered were obtained from two split application at planting and vine initiation and this was followed by the application of 50% dose at planting, 25% dose at vine initiation and 25% dose at flowering to small fruit in both seasons.

Yield and yield components: The yield components such as number of fruits per plant, fruit diameter, fruit weight, number of seeds per fruit, seed yield per fruit, weight of 100 seeds, seed yield per plant and total seed yield per hectare followed the same trend during the 2 seasons (Table 2 and 3). These yield components increased with increasing rates of N fertilizer irrespective of the sources and time of applications in both seasons. Urea recorded high values while CAN gave low values during the 2 seasons.

The time of N applications irrespective of the sources significantly ($p \leq 0.05$) improved the yield of melon during the early and late seasons of 2002. The application of the fertilizer as half dose at planting and the remaining half dose at vine initiation gave the highest yield value irrespective of the N sources. The least yield values were

Table 2: Value of yield components as affected by fertilizer N source and time of application in the early season of 2002 at Ogbomoso

Time and level of N ($kgha^{-1}$)	No of male flower yield per per plant	No of weight per plant	No of female flower per plant	Day to flowering	Fruit fruit fruit (cm)	Fruit 5% fruit (g)	No of diameter per per fruit	Seed weight per fruit	Seed Seeds plant (g)	Total seed yield per hectare (g)	100 seed yield per ($t\ ha^{-1}$)
N_0T^0	20	4.5	2.2	45.8	10.5	1.4	85.6	11.6	25.4	0.25	13.5
N_1T_1	34.2	10.4	3	41	11.8	2	110.7	15.2	45.4	0.46	13.7
N_1T_2	36.8	12	3.8	41.8	12.5	2.3	175	24.5	93.1	0.93	14
N_1T_3	31.6	8.8	2.5	44.1	11.3	1.8	98.6	13.8	34.5	0.35	14
N_1T_4	42.5	14.5	5.1	42	14.7	3.5	236.1	33.5	171	1.71	14.2
N_1T_5	37.5	11.5	4	42.5	14.2	3.3	205.8	29.6	118.5	1.19	14.4
Mean	33.8	10.3	3.4	42.8	12.5	2.4	151.9	21.4	81.3	0.82	11.6
N_0T_0	21	4.4	2.2	45.8	10	1.4	85	11.7	25.6	0.26	13.7
N_2T_1	31.7	10	2.6	41.5	11.2	1.8	96.5	13.1	34.1	0.34	13.6
N_2T_2	35.5	11.5	3	42.3	12.3	2.2	143.2	19.8	59.3	0.59	13.8
N_2T_3	30.3	8	2.3	43.8	10.6	1.6	92	12.9	29.6	0.3	14
N_2T_4	40	13	4.5	41.5	13.5	3.2	215.5	30.8	138.6	1.39	14.3
N_2T_5	32.8	10.7	3.7	43	12.9	3	201.3	28.4	105	1.05	14.1
Mean	31.9	9.6	3.1	42.9	11.8	2.2	138.9	19.5	65.4	0.66	13.9
LSD (0.05):									1.04	ns	
Source(S)	ns	3.52	2.1	ns	3.11	0.86	85.55	12.28	103.72	0.21	0.28
Time (T)	2.79	0.71	0.42	0.3	0.63	0.07	0.07	2.11	20.97	0.21	0.28
SXT	2.79	0.71	0.42	0.33	0.63	0.07	17.3	2.11	20.97	13.6	0.95

S = N source, N_1 = Urea fertilizer, N_2 = CAN fertilizer, T = Time of N application, T_0 = Control, LSD = Least Significant Difference

Table 3: The values of yield components as affected by fertilizer source and time of application in the late season of 2002 at Ogbomoso

Time and level of N ($kgha^{-1}$)	No of male flower per plant	No of female flower per plant	No of fruit per plant	Day to 5% flowering	Fruit diameter per fruit (cm)	Fruit weight per fruit (g)	No of Seeds per fruit	Seed yield per fruit	Seed yield per plant (g)	Total seed yield per hectare (g)	100 seed weight ($t\ ha^{-1}$)
N_0T_0	25.5	6.3	3.5	45.2	11.3	1.5	98.7	13	45.6	0.46	13.2
N_1T_1	39	11.5	4.5	40	12	2.2	152.4	20.6	92.6	0.93	13.5
N_1T_2	42	13.6	6	40.7	12.5	3	185	25.7	154.3	1.54	13.9
N_1T_3	34.5	9.4	4	43.3	11.6	2	123.5	17	68.2	0.68	13.8
N_1T_4	46.1	15.5	7.2	40.5	14.9	3.6	241.3	34	245	2.45	14.1
N_1T_5	43.6	14.2	6.5	41.4	13.6	3.3	215	30.5	198.5	1.99	14.2
Mean	38.4	11.8	5.3	40.9	12.6	2.6	169.3	23.4	134	1.34	1.37
N_2T_0	26.1	6	3.6	45.2	11	1.4	97.5	13.1	47	0.47	13.4
N_2T_1	34.4	11.8	4.1	39.6	11.7	2	135.5	18.3	75	0.75	13.5
N_2T_2	38.6	12.2	5.2	40.5	12	2.5	156.5	21.3	110.7	1.11	13.6
N_2T_3	32.3	10.2	3.8	42	11.3	1.7	108.3	15.2	57.6	0.58	14
N_2T_4	44.5	15	5.6	40.4	14.2	3.5	235.1	33.4	187	1.87	14.2
N_2T_5	39.6	13.7	5.3	42.1	13.5	3.1	209.7	29.4	156	1.56	14
Mean	35.9	11.4	5.3	40.6	12.2	2.3	2.3	21.7	105.5	1	13.7
LSD (0.05):											
Source(S)	13.91	0.44	4.7	ns	1.52	1.11	72.48	11.59	168.22	1.68	ns
Time (T)	8.44	1.12	0.95	0.73	0.23	0.22	14.86	2.34	34.01	0.34	0.31
SXT	8.44		0.95	0.83	0.23		14.86	2.34	34.01	0.34	0.31

S = N source, N_1 = Urea fertilizer, N_2 = CAN fertilizer, T = Time of N application, T_0 = Control, LSD = Least Significant Difference

obtained from plots without fertilizer treatment during the early season. Irrespective of the time of applications Urea gave better yield performance of melon than CAN fertilizer in both seasons.

Composition of nutrient elements in different positions of melon leaf as affected by N fertilizer application: Concentrations of nutrient elements in different positions of melon leaf as influenced by N fertilizer rates in the early and late seasons of 2002 are presented in Table 4. In both seasons, there were significant differences in the composition of various nutrient elements by the N treatments, except for Mg concentration. The composition of N, P and K in leaves decreased with increased in age of the leaves while Ca and Mg contents increased as the position of leaves increased. The 5th leaf position gave the highest compositions of N, P and K but lower concentration of Ca and Mg. However, there is no significant nutrient element concentrations between the 5th and 6th leaf position. The older leaves (i.e., 7 and 8th leaves position) contained the highest concentrations of Ca and Mg. Generally, the concentrations of all the nutrient elements under investigation were more during the late season compared to that of early season.

DISCUSSION

The significant response of melon growth parameters, seed yield and yield components to N sources in both

Table 4: Nutrient elements compositions (%) of different leaf positions as affected by fertilizer N during the early and late seasons of 2002

Leaf position (from top of 1^0 Vine)	N rates									
	N		P		K		Ca		Mg	
	0	60	0	60	0	60	0	60	0	60
Early season										
5th	4.31	4.87	0.47	0.68	3.96	4.87	2.56	2.07	0.65	0.55
6th	4.10	4.67	0.40b	0.67	3.94	4.79	2.61	2.21	0.71	0.58
7th	3.50	3.95	0.38	0.47	3.41	3.59	2.96	2.39	0.76	0.64
8th	3.33	3.55	0.38	0.40	3.18	3.39	3.03	2.48	0.80	0.69
Mean	3.81	4.26	0.40	0.56	3.62	4.16	2.79	23.29	0.73	0.62
Late season										
5th	4.58	5.65	0.65	0.76	4.50	5.55	3.30	3.25	0.68	0.58
6th	4.51	5.52	0.64	0.75	4.46	5.48	3.35	3.28	0.75	0.63
7th	4.05	4.95	0.45	0.63	4.20	5.15	3.76	3.60	0.79	0.68
8th	3.78	4.25	0.40	0.58	4.00	4.52	3.94	3.85	0.87	0.74
Mean	4.23	5.09	0.54	0.68	4.29	5.18	3.58	3.49	0.77	0.65
LSD(0.05)										
Nitrogen (N)	0.15		0.01		0.35		0.11		0.02	
Leaf Position (LP)	0.21		0.01		0.49		0.15		0.03	
Season(S)	0.15		0.01		0.35		0.11		0.02	
NXLP	ns		0.0001		ns		ns		ns	
NXS	0.02		ns		ns		0.01		ns	
SXLP	ns		0.0001		ns		ns		ns	
NXLPXS	Ns		0.00001		ns		ns		ns	

seasons showed that sources of N greatly influenced the growth and yield of melon plants. This is similar to the findings of Ibrahim *et al.* (1986) who examined the effects of N sources on cucumber yield. The highest growth and yield values recorded for urea in both seasons confirmed its superiority over all other sources of N fertilizers. This corroborated earlier reports of other workers (Jones and Wild, 1975; IFDC, 1985). This might be due to the greater ability of urea to supply and make available to the plant substantial amount of N. This therefore, is in line with report of IFDC (1985). that urea has an edge over CAN and urea supergranutes for its high analysis and less problematic method of application. In the recent report of AVRDC (2000) in effect of N fertilizer type and application levels on *Amarantus caudatus,* it was observed that urea produced slightly higher seed yield and number of seeds per plant compared with CAN and ammonium nitrate fertilizers.

The reduced fruit yield in plant receiving N application as entire dose at flowering (7 WAS) might be due to the pre-mature dropping of the fruits as observed on plots receiving this treatment. This may explain the reason why the yield under such treatments similar to that of unfertilized plots. Better growth and yield performance of melon plant under split application of N at half dose at planting and half dose at vine initiation showed that optimum N was available for the adequate vegetative growth and development of melon plants and hence increased in total seed yield.

The significant difference in the various nutrient elements concentrations (except for Mg concentration) as affected by N, fertilizations rates revealed that leaf composition of nutrients are primarily controlled by nutrient supply (Fageria, 1991; Fageria and Baliger, 1997) and the changes in nutrient supply are reflected in the nutrient composition of the leaf (Rocha *et al.*, 1997). The highest concentrations of N, P and K in the 5th leaf and lower concentration of Ca and Mg in the 5th leaf followed closely by 6th leaf position showed that the concentration of N, P and K decreased as the leaves ages while Ca and Mg contents increased with maturity or as the position of leaf increased. These results confirmed the findings of Rocha *et al.* (1997) who reported that age and leaf position affected the nutrient composition of leaf. The reduced concentration of N, P and K contents in older leaves showed that these elements can be recycled from older to younger leaves. N, P and K can readily move from leaf to leaf, whereas Ca and Mg are relatively immobile. According to Taiz and Zeiger (1991) deficiency symptoms of mobile elements will occur first on older leaves while the immobile elements will first become evident in younger leaves. Leaf analysis may therefore, provide a better indicator of nutrient deficiency than the morphological symptoms (Jones *et al*., 1991; Rocha *et al*., 1997).

Critical N, P and K concentration were higher in the 5th and 6th leaves than in the 7th and 8th leaves. Being a slightly mobile elements, N, P and K are translocated to the growing meristem and will tend to accumulate in the youngest plant parts (Westernman *et al*., 1994; Rocha *et al.,* 1997). Therefore, N and P translocation should be taken into account when selecting the time and plant part used for assessing the N and P status of the plant.

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