American-Eurasian Journal of Sustainable Agriculture, 2(3): 225-228, 2008
ISSN 1995-0748

ORIGINAL ARTICLES

Comparative Effects of the Source and Level of Nitrogen on the Yield and Quality of Lettuce

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Olaniyi J.O.; Comparative Effects of the Source and Level of Nitrogen on the Yield and Quality of Lettuce, *Am.-Eurasian J. Sustain. Agric., 2(3): 225-228, 2008*

ABSTRACT

The increasing demand of temperate leaf vegetables in the tropics, calls for more information on their nutrient requirements for optimum performance and nutritional values. A pot experiment was conducted to evaluate the effect of N sources on the yield and quality of lettuce in south west Nigeria in 2005. The N sources were poultry manure (0, 1.0, 1.5 and 2.0 Mt. ha^{-1}), organomineral fertilizers (o, 10, 20, 30, 40, and 50 kg ha^{-1}) and urea (0, 15, 30 and 45 kg ha^{-1}). Treatments were laid out in a completely randomized design and replicated three times. Growth, yield and quality data were collected. The results showed that the applications of poultry manure (PM), organomineral (OMF) and urea (N) fertilizers significantly ($p<0.05$) influenced the yield and quality of lettuce. The optimum yield, nutrient uptake and quality of lettuce were obtained at 1.5 Mt. PM ha^{-1}, 40 Kg. OMF ha^{-1} and 30kg. Nha^{-1} fertilizers application. However, organomineral fertilizer applied at 40 kg ha^{-1} recorded the highest marketable yield of lettuce as compared with the values obtained from PM at 1.5Mt. per ha^{-1} and urea at 30 kg.N ha^{-1}. Although, urea gave the best performance in terms of quality of lettuce there was no significant difference from those obtained from that of poultry manure and organomineral fertilizer.

Key words: *Lactuca sativa* L., Nitrogen sources, growth, yield, quality.

Introduction

Lettuce (*Lactuca sativa L*) is a relatively recent introduction into the tropics. It can be grown in pure stands or in association with erect plants which provide only slight shade, and optimum growth. It requires a very moist environment and a sandy or loamy soil, Lettuce is grown mainly as a salad crop, but the leaves may be boiled just like spinach. The composition of lettuce leaves is approximately 94.3% water, 1.2% protein, 0.2% fat, 2.9% carbohydrate (CHO), 0.7% fibre and 0.7% ash. It is rich in vitamin A and E and minerals such as calcium, phosphorus, sodium, magnesium and potassium. Lettuce is esteemed for its flavour rather than for its nutrient value. (Kochhar, 1986; Purseglove, 1991; Raymond, 1997).

Nitrogen (N) is an important plant nutrient which can be absorbed primarily in the form of nitrate. It constitutes about 1.5-6% of the dry weight of many crops (Tsidale and Nelson, 1990; Jone *et al.,* 1991). Nutrient are used in moderate amounts on lettuce and there is a need to use with care, especially in the last half to third of the growing season. Excess nitrates late in the growing season tend to cause loose heads. Excess N causes increased susceptibility of vegetable crops to fungus disease and deterioration of post harvest quality (MacGillivray, 1961; Collingwood, 1988). However, insufficient fertilization retards development, reduces quality and encourage bolting in lettuce (Collingwood, 1988). This research is aimed at determining the best N-source and rate for maximum yield, and quality of lettuce.

Materials and methods

The experiment was carried out in 2005 at the Ladoke Akintola University of Technology, Ogbomoso (4^0 10'E and 8^0 10'N) in south west Nigeria. Annual rainfall of this area is over 1,000 mm and air temperature ranges between 21^0C and 33^0C (Olaniyi, 2000). A completely randomized design was employed to investigate the effect of N

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sources: poultry manure applied at 0 ,1.0 ,1.5 and 2.0Mt.ha-l; organomineral fertilizer at 0, 10, 20, 30, 40 and 50 kgha^{-1} ; and urea at 0,15, 30 and 45kg ha^{-1}, on the yield and quality of lettuce. Lettuce seedlings were raised in seed boxes containing sterilized soil beginning early May and watering, weeding and pests and diseases control were carried out until transplanting.

The soil used was collected from the top 0-15cm depth on the university's Teak plantation, and was analysed for nitrogen, organic carbon, phosphorous, calcium, potassium, sodium, magnesium and pH, after air – drying and sieving through 2 mm mesh. Total N and available P was determined with a Technicon AAII (Technicon, 1975; 11TA, 1982). Soil pH (IITA, 1982), soil organic carbon by the Walkley Black modified method (Black, 1965; 1976), and exchangeable Ca, Mg, Na and effective C. E. C. in soils with an atomic absorption spectrophotometer.

The experimental site was prepared by clearing all vegetable. Black polythene bags of 23 cm diameter and 36 cm depth were filled up with 20 kg of soil. Thirty-six black polythene bags used for the experiment were arranged in three rows with each row containing 12 bags and spaced 1m x 0.5 m apart.

Lettuce seedlings were transplanted four weeks after sowing into the polythene bags. Irrigation was provided immediately after transplanting and at two-day interval there after to ensure better crop establishment in the first two weeks (Olaniyi and Fagbayide, 1999). Nitrogen as described above was applied two weeks after transplanting to the soil and incorporated. Karate 2.5EC was applied bi – weekly, beginning from two weeks after sowing at a rate of 5ml. L^{-1} of water to control insect pest and weeding was done manually.

Reponse to the different N sources and rates were assessed based on number of leaves, and fresh and dry weight yield of harvested heads. After determination of fresh weight heads were dried in an oven at 60^{0}C for 48 hours. Dried samples were milled and ground for tissue analysis. Total P was determined by the Vanadomolybdate method, K and Ca were determined by flame photometry and Mg and Fe were determined by atomic absorption spectrophotometer (IITA, 1982). Total N was analysed by the micro-Kjeldahl procedure and crude protein was obtained by multiplying the total N by a factor of 6.25. All data were subjected to analysis of variance and means were compared by the least significant difference at 0.05 probability level.

Results and discussion

The results of the soil analysis taken before the start of the experiment are presented in table1. The soil was sandy loam and the N and P contents in the soil are generally low. This may be due to the low soil organic matter, hence the need for soil amendment in form of organic or inorganic fertilizer application.

The effect of sources and level of N on the number of leaves of lettuce is shown in table. 2. The number of leaves increased as the plant matured, with or without N application. The average number of leaves significantly influenced by the poultry manure, organomineral and urea at 6 WATP and at harvesting (8 WATP). It increased with N rates and then declined at higher N rates of all N sources. Organomineral fertilizer applied at 40 kg. N ha^{-1} gave the highest number of leaves of lettuce compared with the values obtained from PM at 1.5 Mt. PM ha^{-1} and urea at 30 kg. ha^{-1}. of N. This agrees with the work of Tisseli (1999) on lettuce, that a combination of organic and mineral fertilizer (as may be represented by OMF) gave higher yields of marketable heads of lettuce. The optimum values obtained for the number of leaves at 1.5 Mt. ha^{-1} was similar to the findings of Hamdar and Rubeiz (2000) who observed an increase in the number of leaves of lettuce with applied PM and then a declined at higher rate.

Both the fresh and dry weights of lettuce were significantly affected ($p<0.05$) by the source and level of N (Table 3). The fresh weights of lettuce of urea fed plants were significantly higher than those of OMF and PM fed plants. PM at 1.5 Mt. ha^{-1} gave the highest dry weight of lettuce closely followed by OMF at 40 kg ha-l, while the least values were recorded for urea at 30 kg. ha-l . The initial increase followed by a declined in a weight at higher N fertilizer application rates confirms the works of Knavel *et al.* (1977) and Locasco *et al* (1984) that yield decreases at higher N rate. The decreased in yield at higher N rate might also be due to the excess fertilizer application.

Table1: Physical and chemical characteristics of the soil.

Parameters	Value
PH (H_2O)	6.9
Total N (%)	0.10
P (ppm)	5.77
Exchangeable cations (cmoI/kg	
Ca^{2+}	2.25
Mg^{2+}	1.12
Na^{+}	0.04
K^{+}	0.24
Physical characteristics	
Sand (%)	86.7
Silt (%)	9.2
Clay (%)	41
Textural class	Sandy loam

Generally, N balance is required for the optimum growth and development of vegetable crops, but excess N causes increase susceptibility of vegetable crops to fungus diseases and deterioration of keeping quality (Collingwood, 1988). However, deficiency of N causes progressive chlorosis of foliage, poor growth and premature fall of the lower leaves of vegetable crops (Collingwood, 1988); matured early with yield and quality significantly reduced (Collingwood, 1988; Jones et al, 1991). The decreased in yield as the N source rate increased suggested that nutrients should be used in moderate amount on lettuce, and there is need to use N with care especially in the last half or last one third of the growing season when excess nitrate tends to force and cause losses of heads (MacGillivray, 1961).

Table 2: Effects of source and level of N on the average number of leaves of lettuce.

Number of leaves					
N level (kg ha^{-1})	At transplanting	2 WATP	4 WATP	6 WATP	8 WATP (harvesting)
	6.00	6.67	7.67	7.67	7.67
1.0t pm ha-1	7.67	7.67	9.67	15.00	16.67
1.5t pm ha-1	8.00	8.00	9.67	16.00	19.00
2.0t 0m ha-1	7.00	7.00	9.00	15.67	17.67
10kg 0mf ha-1	5.67	6.00	6.67	10.00	11.67
20kg 0mf ha-1	5.00	5.00	6.00	10.00	12.00
30kg 0mf ha-1	7.00	8.00	9.00	18.67	20.67
40kg 0mf ha-1	7.67	8.00	10.00	18.67	21.67
50kg 0mf ha-1	7.67	7.67	8.00	13.67	15.67
15kg urea ha-1	7.67	8.00	9.67	13.67	15.67
30kg urea ha-1	9.00	9.00	9.67	13.67	15.00
45kg urea ha-1	8.67	8.67	9.00	11.67	15.00
LSD(0.05)	Ns	Ns	Ns	8.43	9.65
CV (%)	19.5	20.5	25.6	36.6	36.3

Table 3: Effects of source and level of N on fresh and dry weight of lettuce.

N level (kg ha-1)	Fresh weight (kg/ha)	Dry Weight (kg/ha)
0 (control)	0.08	0.05
1.0t pm ha-1	0.58	0.06
1.5t pm ha-1	0.65	0.08
2.0t pm ha-1	0.38	0.06
10kg 0mf ha-1	0.30	0.03
20kg 0mf ha-1	0.35	0.03
30kg 0mf ha-1	0.58	0.05
40kg 0mf ha-1	0.68	0.07
50kg 0mf ha-1	0.65	0.05
15kg urea ha-1	0.67	0.03
30kg urea ha-1	0.96	0.05
45kg urea ha-1	0.88	0.03
LSD (0.05)	0.43	0.04
CV (%)	4.56	5.09

The quality and chemical composition of *Lactuca sativa* plants as affected by the three sources and levels of N are shown in Table 4. P, K, Ca and Fe contents increased significantly ($p \leq 0.05$) with increasing N application under the difference sources of N. But higher contents of these nutrients elements were observed in the plants grown under urea while the least values were recorded for poultry manure. Similarly, the water content in plants increased with increasing N application under all N sources used. However, urea enhanced water content more than OMF and PM.

Table 4: Effect of source and level of N on proximate analysis of lettuce.

Nutritive values										
N levels (kg ha^{-1})	%H_20	% Fat	% CHO	% Protein	%Fibre	% Ash	% P	% K	% Ca	%Fe
0 (control)	90.43	0.27	210	1.17	1.39	1.54	23.67	20.67	0.30	0.01
1.0t pm ha^{-1}	90.43	0.28	3.20	1.56	0.64	1.53	30.50	29.17	0.05	1.00
1.5t pm ha^{-1}	92.07	0.37	3.77	2.23	0.64	1.15	42.06	35.17	0.60	2.00
2.0t pm ha^{-1}	93.10	0.32	2.63	2.04	0.57	1.83	45.49	35.70	0.80	2.70
10kg 0mf ha^{-1}	89.50	0.39	3.39	1.03	1.18	1.28	44.24	32.33	0.40	0.30
20kg 0mf ha^{-1}	91.87	0.40	3.81	1.53	0.67	1.23	48.80	34.50	0.50	1.50
30kg 0mf ha-1	92.13	0.45	3.90	1.96	0.58	1.22	54.87	36.00	0.50	2.00
40kg 0mf ha^{-1}	92.20	0.51	4.70	2.33	0.51	1.02	56.43	39.20	0.60	2.60
50kg 0mf ha^{-1}	92.32	0.37	2.95	2.04	0.46	2.35	58.80	44.50	0.40	3.00
15kg urea ha^{-1}	90.03	0.31	2.77	2.42	0.75	2.35	55.57	33.55	1.00	1.10
30kg urea ha^{-1}	93.18	0.53	4.72	2.74	0.61	1.11	98.67	40.00	1.60	3.00
45kgurea ha-1	98.41	0.40	4.17	1.90	0.45	0.90	107.70	49.18	2.00	4.00
LSD (0.05)	0.07	0.01	0.05	0.07	0.02	0.03	0.02	0.03	Ns	0.01
CV (%)	0.05	1.9	0.8	2.1	1.3	1.4	0.2	0.5	114.3	3.0

The protein, fat and carbohydrate contents increased sharply in the shoot of *lactuca sativa* with the application of 1.5 Mt. PM 40 kg OMF, and 30 kg. N ha^{-1} of urea. Further increase in N application beyond these optimum levels resulted in a decrease in protein, fat and carbohydrate contents. The crude fibre and Ash contents of *L. sativa* shoots decreased with increasing level of N application regardless of the N source. However greater accumulations were observed under poultry manure nutrition. The highest level of accumulation being recorded at the zero levels of N. it has been observed that the uptake of N inform of Nitrate stimulates the uptake of cations (Jones *et al*., 1991). Also, the works of Fawusi and Fafunso (1981) on corchorus, and Olaniyi (2000) on melon showed that N sources and rates, and NPK fertilizer respectively, increased the quality and chemical of these crops.

Generally, although the best yield, quality and chemical composition were observed for *L. sativa* plants grown under urea nutrition, there is no different between the values and those obtained for plants that received organomineral as N source.

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