SRYAHWA PUBLICATIONS

International Journal of Research in Agriculture and Forestry
Volume 2, Issue 8, August 2015, PP 1-5
ISSN 2394-5907 (Print) & ISSN 2394-5915 (Online)

Effect of *Chromolaena Odorata* Residue and Urea Fertilizer on Plant Available Nitrogen, Growth and Yield of Maize (*Zea Maysl.*) in Ejiba, Kogi State, Nigeria

Ogundare, S. K.[1], Babatunde, I. J.,[2] Aduloju, M. O.[3], Hinmikaiye, A.S[1].

[1]*DAC/ABU Kabba, Kogi State, Nigeria*
[2]*Federal University of Technology, Akure, Nigeria*
[3]*Landmark University, Omu- Aran, Kwara –State*

ABSTRACT

Field experiments were conducted at Lower Niger River Basin and Rural Development Authority, Ejiba to examine the effects of *Chromolaena odorata*residue and urea fertilizer on plant available nitrogen, growth and yield of maize. The experimental design employed was randomized complete block design (RCBD) consisting of six (6) treatments with three(3) replicates. The treatments consisted of the following: Urea (mineral fertilizer) at 260 kg/ha, 10t/ha *Chromolaena odorata* stem & Leaf, 8t/ha *Chromolaena odorata* residue + 52 kg/ha urea, 6t/ha *Chromolaena odorata* residue + 104 kg/ha urea, 4t/ha *Chromolaena odorata* residue + 156 kg/ha urea and 2t/ha *Chromolaena odorata* residue + 208 kg/ha urea. Maize seeds (ACR 9931 DMR - SR - Y) were sown at a spacing of 90 cm between rows and 30cm within rows. Soil sample was collected and analysed for soil organic carbon and mineral nitrogen. Data were taken on agronomic traits such as plant height, leaf area, stem diameter and days to50% tasselling. Yield parameters taken were number of seed per cob, grain weight per plant (kg), and weight of 1000 seeds. Data collected was subjected to analysis of variance (ANOVA), and the means were separated using Duncan Multiple Range Test at 5% level of probability. The integrated use of *Chromolaena odorata* residues and mineral fertilizer(urea) showed promising potential in conserving soil fertility and improve the yield of maize in the study area. It is recommended that the use of *Chromolaena odorata* residue at 6t/ha plus urea fertilizer at 104kg/ha be adopted for maize cultivation in the study area.

Keywords: Nutrient, Maize, Residue, Organic, Inorganic and Fertilizer

INTRODUCTION

Maize is the miracle seed of Nigeria's agricultural and economic development. It has established itself as a very significant component of the farming system and determines the cropping pattern of the most peasant farmers. The area of land under maize crop cultivation in Nigeria is about 2-3 million ha and its cultivation in the savannah continues to increase (FFD, 1989). Despite the advantages of maize, the production is still low; this is largely due to poor use of available resources for production, lack of adequate knowledge about some agronomic practices and poor fertility status of Nigerian soils (Babalola, 2005).The crop also requires adequate soil fertility for high productivity in which it requires relatively higher N, P and K than other elements. Idachaba (2006) reported that crop output of countries correlates strongly and positively with fertilizer consumption. Soil N dynamics is characterized by a series of transformation processes between organic and inorganic forms of N. Soil N pool is affected by inorganic N which is derivable from mineralization process, N addition via fertilizer usage and soil N losses via leaching or volatilization, N removal by crops and/or addition of N fertilizer materials to soil, microbial immobilization or fixation. Accurate estimation of the capacity of the soil to mineralize organic nitrogen is important. Nitrogen is the key element in plant production and modern farming systems require an ample supply of N fertilizer necessary for maximum crop yield.This study was therefore carried out to determine the effect of urea fertilizer and *Chromolaena* residue on plant available nitrogen, growth and yield of maize (*Zea mays* L.) with the aim of determining the optimum combination of urea fertilizer and Chromolaena residue required for high productivity.

Address for correspondence:

drogundarekayode@yahoo.com

MATERIALS AND METHODS

Field Operation: Field experiments were carried out at the Lower Niger River Basin Development Authority, (L.N.R.B.D.A), Ejiba, Yagba West Local Government Area of Kogi State, Nigeria in 2012 and 2013 cropping seasons. Ejiba is located on latitude 8^0 18' N and longitude 50^0 39'E in the southern guinea savanna agro ecological zone of Nigeria. The Soil at Ejiba is an ultisol. In the study area, rainfall is monomodal and occurred from April to September. The experiments were arranged using Randomized Complete Block Design (RCBD) in three replicates. The treatments consisted of the following: Urea(Mineral fertilizer) at 260,8 kg/ha, 10t/ha *Chromolaena odorata* residue (Stem & Leaf), 8t/ha *Chromolaena odorata* residue + 52 kg/ha urea, 6t/ha *Chromolaena odorata* residue + 104 kg/ha urea, 4t/ha *Chromolaena odorata* residue + 156 kg/ha urea and 2t/ha *Chromolaena odorata* residue + 208 kg/ha urea.

Crop Establishment: Each year experiment was conducted using a single field having dimension of 29m by 14m which was laid out into three blocks with 1m guard row plots. Three maize seeds (ACR 9931 DMR - SR - Y) open pollinated, downy mildew and streak resistant yellow grain variety were sown per stand manually, at a spacings of 90 cm between rows and 30cm within rows. The fully emerged plants were thinned to two per stand while urea fertilizer and organic manures were split applied at planting and at 6 weeks after planting (IAR & T, 2000). Weeding was done manually at 3 and 8 weeks after sowing.

Soil Sampling and Analysis: Before the commencement of the experiment in 2012, surface soil samples (O – 15cm depth) were taken randomly from the experimental sites. The samples were bulked, air dried and sieved using a 2mm sieve and analyzed for particle size, soil organic matter, total N, P, K, Ca, Mg and pH. Soil samples (O – 15cm depth) were also collected at 30, 60, 90 and 120daysintervals and were subjected to routine physical and chemical analyses. Particle size analysis was done using hydrometer method (Bouyoucos, 1962) while organic matter was determined by the procedure of Walkley and Black using the di -chromate wet oxidation method (Nelson and Sommers, 1982). Total N was determined by micro – Kjeldahl digestion method (Bremner, 1965) and available P was by Bray P – 1 extraction followed by molybdenum blue colorimetry (Bray and Kurtz, 1945). Exchangeable K, Ca and Mg were extracted by EDTA titration method (Jackson, 1962). Soil pH was determined in 1:2 soils – water ratio using digital electronic pH meter.The concentrations of NH_4–N and NO_3–N in the KCl extracts were determined by flow injection analysis and spectrometric detection (FIAstar 5000 Analyzer, Foss Tecator, Denmark). Analysis of NH_4–N was by the gas semi-permeable membrane method according to the ISO 11732 procedure (1997). Analysis of NO_3–N was by the sulphanilamide-naphtylethylendiamine dihydrocloride method, after preliminary reduction of NO_3 to NO_2 by a copper-cadmium reductor column, according to the ISO 13395 procedure (1996). Plant available N (PAN) was calculated as the Soil Mineral Nitrogen (SMN) in the manured treatments minus the SMN in the unmanured control. PAN was expressed as a fraction of added manure N. Measurements of microbial biomass was done using chloroform fumigation – incubation methods (Jenkinson and Powlson, 1976; Wardle and Parkinson, 1990a), the procedure described by Wardle *et al*.(1993) and modified by Wilson *et al*.(2000) was adopted.

Agronomic Data Collection

Agronomic data such as plant height (cm), stem girth (cm), leaf area and days to 50% tas selling were determined at crop maturity (60 DAT). Yield data such as number of seed per cob, 1000 seed weight (g) and seed yield (t/ha).

Data Analysis

Data was statistically analysed using GENSTAT. The analysis of variance (ANOVA) was performed to find out the significance of variation among the treatments while the significance difference between mean treatments were separated using the Duncan's Multiple Range Test (DMRT) at 5% level of probability.

RESULTS AND DISCUSSION

The properties of the soil at the site of the experiment were presented in Table 1. The soil was predominantly sandy and slightly acidic, low in nitrogen content, low phosphorus content and a high quantity of potassium (Ogundare *et al.*, 2013). Application of*Chromolaena odorata* residues is expected to benefit both the soil and the crop. The chemical composition of *Chromolaena odorata* residues used indicated relatively high in the essential nutrient required for the growth and development of okra (Table 2).

The effects of organic amendment of soil on the dynamics of biota activity and soil nutrient contents in terms of soil organic carbon, total and plant available N were monitored (Table 3). Treatment effects were profound on the time trends of soil organic carbon (SOC) and mineral N (NH_4^+ and NO_3^- N) pools, and differences were obtained in the values of SOC, NH_4^+ and NO_3^- N at the various dates of sampling (Table 3). Trends of the time dynamics of SOC and plant available forms of nitrogen (NH_4-N and NO_3-N) show that peak values were obtained at 30 and 60 days after planting (DAP) and these values declined subsequently after. Across the sampling dates, average values of SOC were 1.43, 1.31and 1.20mg/g for organic wastes alone, organic waste plus mineral fertilizer (Table 3). SOC values were highest in *Chromolaena odorata* residue (6t/ha) + urea (104kg/ha)(1.60). Differences were also obtained for inorganic N in the soil at the various dates of sampling. However, average values indicated that SOC, NH_4^+ and NO_3^- turnover rates were comparatively greater in the organic amended than in mineral fertilizer amended plot. NO_3^- N plus exchangeable NH_4^+ N were relatively high at 30 and 60 days after planting, and this trend was consistent among the treatments. The higher values were followed by consistent decline afterwards especially at the end of the experiment (120 DAP). This indicates that the *Chromolaena odorata*residue whether applied solely or at a reduced rate combined with urea had high mineralization rates. Among the different combinations,6t/ha *Chromolaena odorata* residue plus 104kg/ha urea produced the highest values of SOC and mineral N while the plot amended with mineral fertilizer had the least values of these parameters. The NO_3^- + exchangeable NH_4^+ (PAN) recovered from organically amended soils or in combination with urea were higher than the mineral fertilizer alone plot. PAN was relatively high for a trend that was consistent among the plot with *Chromolaena odorata* residue plus urea. Among the integrated applications tested, rates of mineralization were similar. This suggests that the forms of organic N contributing to the mineralizable forms of N among the applied *Chromolaena odorata* residue are similar.

Effects of *Chromolaena Odorata* Residue and Urea Fertilizer on Growth Components of Maize

Table 4 shows the effect of integrated application of *Chromolaena odorata* residues and urea fertilizer on stem girth, leaf area, plant height and days to 50% tasselling. The results show that stem girth and plant height were significantly affected by the treatments. Among the integrated applications, *Chromolaena odorata* residues (6t/ha) + urea(104kg/ha) increased stem girth, leaf area and plant height and reduced days to 50% tasselling in maize over urea fertilizer and *Chromolaena odorata* residues sole application. All plots with application of *Chromolaena odorata*residues + urea fertilizer had similar effects on stem girth, leaf area and plant height respectively. The least values of stem girth, leaf area and plant height and greatest delay in days to 50% tasselling were obtained from urea amended plot. The result shows that application of *Chromolaena odorata*residues + urea fertilizer, irrespective of the rate of combination improved growth component of maize.Isirimah and Douglas (1991) applied poultry waste, cow dung and oil palm mill sludge and their combination with NPK fertilizer on entisol and mangrove soils and reported an improvement in maize plant height, leaf area and root length when the organic residues were combined with NPK fertilizer. Smith and Ayenigbara (2001) observed top growth, weight and, highest yield of Indian spinach with the application of poultry waste or in combination with reduced rates of NPK fertilizer. The better maize growth observed for *Chromolaena odorata* residues plus urea fertilizer can be attributed to nutrients release efficiency of both urea fertilizer and *Chromolaena odorata* residues. It is probable that nutrient use efficiency of maize might have increased through combination of manure and mineral fertilizers.

Effects of *Chromolaena Odorata* Residue and Urea Fertilizer on Yield Components of Maize

Table 5 shows the effects of *chromolaena* residues and urea fertilizer on yield and yield components of maize. Application of *Chromolaena odorata* residue significantly (P = 0.05) increased the number of seeds per cob, 100 seed weight and seed yield of maize. The results show that plots treated with *Chromolaena odorata* residue (6t/ha) + urea(104kg/ha produced highest values of seed weight, number of seeds per cob, 100 seed weight and seed yield per land area. All integrated plots produced similar grain weight per plant, 100 seed weight, number of seed per cob and seed yield. Urea amended plot produced the least values of seed weight per plant, number of seeds per cob, 100 seed weight and grain seed/ha. Ogundare(2011) reported that combination of organic residues with different rates of mineral fertilizer improved soil physical and chemical conditions and maize performance. This result implies that integrated application of both *Chromolaena odorata* residues and urea fertilizer would enhance maize yields over sole application of urea and organic residue. The integrated use of *Chromolaena odorata* residues and mineral fertilizer(urea) showed promising potential in conserving soil fertility and improve the yield of maize in the study area. It is recommended that the use of *Chromolaena odorata* residue at 6t/ha plus urea fertilizer at 104kg/ha be adopted for maize cultivation in the study area.

Table1. *Pre planting soil analysis of the experimental sites*

Properties	*2012*
Particle size	
Sand (%)	55.2
Clay (%)	26.4
Silt (%)	18.4
Soil texture	Sand clay
pH	6.4
Bulk density (g/cm^3)	1.27
Total porosity (%)	40.6
Organic matter (%)	2.13
Total N (%)	0.17
Available P (mg/kg)	2.44
Exchangeable cations (cmol/kg)	
K	0.56
Ca	2.62
Mg	3.39

Table2. *Chemical properties of Chromolaena odorata*

Properties	Chromolaena odorata residues
Organic carbon (%)	48.8
Total N (%)	3.4
C/N	14.4
Phosphorous (%)	1.7
Potassium (%)	0.9
Calcium (%)	1.6
Magnesium (%)	0.6

Table3. *Effect of Chromolaena odorata residue and urea fertilizer on plant available nitrogen*

Treatment	*Organic C*	*(mg/kg)*		*NH_4-N*	*(µg/g)*				*NO_3-N*	*(µg/g)*			
Kg/ha	30	60	90	0	30	60	90	120	0	30	60	90	120
U(260)	0.24	1.04	0.82	42	320	151	46	07	37	26	18	8	2.4
C(10t)	1.25	1.55	1.50	43	331	157	53	15	36	28	11	4	1.2
C(8t) +	.83	1.12	1.06	54	363	173	54	08	34	26	11	5	1.5
U(52kg)													
C(6t) +	1.42	1.71	1.67	40	326	154	71	11	42	32	10	4	1.3
U(104kg)													
C(4t) +	1.26	1.56	1.48	52	347	168	63	10	41	33	13	5	1.6
U(156kg)													
C(2t) +	1.20	1.23	1.20	37	322	152	48	11	35	25	19	4	1.1
U(208kg)													

Legend: *urea (u);Chromolaena odorata residue (c); tonnes (t); hactare (ha) and kilogram (kg).*

Table4. *Effect ofChromolaena odorata residue and urea fertilizer on growth character of maize*

Organic residues	Stem girth (cm)	Leaf area (m^2)	Plant height (cm)	Days to 50% tasselling
U(260kg)	2.64^c	0.43^b	112.4^c	49^a
C(10t/ha)	3.30^b	0.48^a	173.3^{ab}	49^a
C(8t)+u(52kg)	3.15^b	0.50^a	168.1^{ab}	49^a
C(6t)+u(104kg)	3.72^{ab}	0.52^a	206.1^a	48^a
C(4t)+u(156kg)	3.90^a	0.58^a	208.4^a	48^a
C(2t)+u(208kg)	3.27^b	0.48^a	189.3^{ab}	48^a

Legend: *urea (u);Chromolaena odorata residue (c); tonnes (t); hactare (ha) and kilogram (kg).*

Table5. *Effect of Chromolaena odorata residue and urea fertilizer on yield characters of maize*

Organic residues	Seed yield (t/ha)	100 seed weight (g)	Number of seeds/cob	Seed wight/plant (g)
U(260kg)	2.42[c]	0.21[a]	325[d]	55.23[c]
C(10t/ha)	3.58[b]	0.22[a]	386[c]	62.91[a]
C(8t)+u(52kg)	3.49[b]	0.22[a]	357[c]	61.36[a]
C(6t)+u(104kg)	3.89[a]	0.22[a]	541[a]	63.23[a]
C(4t)+u(156kg)	3.43[b]	0.22[a]	452[b]	61,16[a]
C(2t)+u(208kg)	3.46[b]	0.22[a]	421[b]	58.38[b]

Legend: *urea (u);Chromolaena odorata residue (c); tonnes (t); hactare (ha) and kilogram (kg).*

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