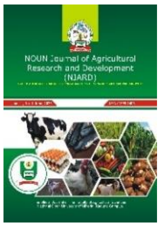
p-ISSN: 1595-1405

NOUN Journal of Agricultural Research and Development (NJARD)

The Official Journal of the Faculty of Agricultural Sciences, National Open University of Nigeria, Kaduna Campus

Journal homepage: https://journal.agric.nou.edu.ng



Original Article

OPEN ACCESS

Consequences of Gramoxone Application on some Soil Properties on the Germinations and Growth Parameters of Okra in Obioakpa, Akwa Ibom State, Nigeria.

Udoumoh, I. D.J.[1] & Udoh, U. S.[2]

[*1] *Department of Soil Science, Faculty of Agriculture, Akwa Ibom State University, ObioAkpa Campus, Oruk Anam LGA, Akwa Ibom State, Nigeria.* [2] *Department of Soil Science, College of Agronomy, Joseph Sarwuan Tarka University, Makurdi, Benue State, Nigeria.*

[*]Correspondent email: *itoroudoumoh@aksu.edu.ng*

Editor: *Dr. Sunday N. Obasi*
National Open University of Nigeria

Received: *July 16, 2025*
Accepted: *March 30, 2026*
Published online: *June 25, 2026*
Peer-review: Externally peer-reviewed

Conflict of Interest: *The authors have no conflicts of interest to declare*

Financial Disclosure: *The authors declared that this study has received no financial support*

Abstract

A field study was carried out at the Teaching and Research farm of Akwa Ibom State University ObioAkpa Campus, between January and February 2025, to evaluate the effect of gramoxone herbicide on selected soil properties, germination, and growth parameters of okra in ObioAkpa. The experiment was carried out in a randomized complete block design, replicated three times in 3x4 factorial arrangements. Factor 'A' was an okra variety (East West Safa), while treatments were four (4) rates of gramoxone herbicides (0, 3, 4 and 5l/ha). Data collected from the growth parameters were subjected to analysis of variance. Significant means were compared using least significant difference (P < 0.05). Results showed gramoxone herbicide applied at 3L/ha enhanced a high germination rate (89.00% at 5 days after planting (DAP)). Also, 3L/ha of gramoxone herbicide promoted a high number of leaves each week after planting: 2WAP(5.10), 3WAP(3.89), 4WAP(3.89), 5WAP(4.11), 6WAP (4.33), and 7WAP(4.33). In plant height and leaf area, 3WAP of gramoxone herbicides indicated a significant difference (p<0.05) with high leaves of plant height and leaf area, followed by 5L/ha. The least plant height and leaf area were recorded in 4L/ha of gramoxone. The study therefore recommended gramoxone herbicide application at 3L/ha to farmers in ObioAkpa and its environs.

Keywords: Gramoxone herbicides, Soil properties, Growth parameters, Okra

INTRODUCTION

Herbicides according to (Holt, 2013), are chemicals used to promote the growth of specific plants by reducing the population of unwanted plants in the ecosystem. They usually attack plants through the sub-terminal parts or above the ground, leaving behind some traces of toxins which impinge on both the plants they were meant to maintain and some soil microbes. Apart from being weed killers, herbicides have been variously used to change the soil's physical, chemical and biological properties, besides altering the genetic structure of organisms. The effect of herbicides includes regulation of the cell, regulation of specific enzymes such as RNA polymerase, and alteration of protein and nucleic acid synthesis. Lores *et al*., (2005), reported that herbicides produced a pronounced effect on the structure of the chromosome, which carries genetic factors or genes. Besides being weed killers, most herbicides undergo photochemical adjustment to release metabolites that are injurious to both man and the environment (Kole*et al.*, 1999).

Herbicide enhances food production, but in most cases, they result in harmful effects on soil properties (Bassey *et al*., 2019; Omar.and Tasi^u, 2020). Numerous brands of herbicide are on the market, with gramoxone brand being the most widespread in the study area. Gramoxone herbicides or Paraquat (1, 1'–dimethyl–4, 4' Bipyridinium Chloride) is a non-selective herbicide of ammonium compound, soluble in water restricted action just like any other contact herbicide. It restrains photosynthesis in light-exposed plants and accepts electrons from photosystem-1, conveying them to molecular oxygen. In this manner, negative reactive oxygen species are formed. Informing these reactive species, the oxidized form of paraquat is reduced and is once more offered to push electrons from photosystem-1 to initiate the cycle again (Beckie, 2011). It damages plant tissue very speedily, particularly in sunny conditions/temperatures. The germination and growth of plants such as okra (*Abelmoscus esculentus*) are altered by it. In recent times, the extent to which herbicides are used to manage weeds (both in the farm and residential areas) has caused a serious menace to human welfare (Buzik,1997). This research was geared toward determining the effect of different rates of gramoxone herbicides on some selected soil properties, germinations and growth parameters of okra in ObioAkpa, Akwa Ibom State, Nigeria. The objectives of the study were to determine the physicochemical properties of the soil of the study area before and after the application of gramoxone herbicide, to determine the effect of different rate of gramoxone application on the germination and some growth parameters of okra and to determine the effect of gramoxone herbicide on selected soil properties

Materials and Methods:

Location: This study was conducted at the Akwa Ibom State University Teaching and Research Farm, ObioAkpa Campus. It is located between latitudes $4^0 30^I$ N and $5^0 30^I$ N and longitude $70^0 30^I$E and $80^0 00^I$E of the equator. ObioAkpa is within the humid tropical region with a mean annual rainfall ranging from 2500-3000mm. The temperature range is between $23\text{-}27^0$ and a relative humidity ranging from 75-79%. The soil is acidic and the vegetation is mostly secondary forest (Uduak *et al.*,2018).**Agronomic Practices:** The site was manually cleared of the vegetation with machetes. Beds were made with a spade after marking out the field. The beds were ploughed and harrowed to fine till. Experimental Design and Treatment Application: The experiment was laid out using the randomized complete block design (RCBD). The herbicide was used at four (4) levels of treatment applications: 0 (control), 3, 4, and 5L/ha with three replications for each. Each replication has four plots representing the treatment rate, and each plot was measured 2m x 2m. The distance between the replications was 1.5m, while the distance between treatment plots within a replication was 1m. Each treatment was mixed with 120ml of clean water and poured in to a knapsack sprayer and sprayed on the soil of its corresponding plots. A specific plot application was worked out based on the manufacturer's recommendations.

Soil Sample Size and Sampling Technique: Four composite soil samples were taken at 0-15 cm depth from the experimental field before the application of gramoxone to determine the physicochemical properties of the soil. Another set of four composite soil samples were collected thirty days after treatment application for the assessment of the effects of gramoxone herbicide on soil properties, germination, and growth of okra. Planting was done using okra (safa) seed after land preparation. It was planted at a spacing of 50 cm x 50 cm with two seeds per plant.

Data Collection and Analysis: Six plants were randomly tagged with an experimental unit for data collection (germination and growth). Data collected were subjected to analysis of variances (ANOVA), while the Least Squares Difference (LSD) was at 5% significance level.

Growth Parameters: - Germination Percentage (%): The conventional germination percentage was determined at DAY 4 TO DAY 6 after planting and calculated as the number of germinated stands over the total number of plant stands in the experimental unit and expressed in percentage.

Plant Height (cm): The plant height was measured weekly. Measurement was taken from the soil level to the terminal of each tagged plant using a graduated pole.

Leaf Number: The numbers of leaves were determined by counting all the functional leaves per plant weekly.

Leaf Area: The leaf area was determined using measuring the length and multiplying it by the width of all the leaves of the tagged plant.

Laboratory Analysis:- Physicochemical Analysis: The four composite soil samples collected for physicochemical analysis were air-dried, crushed and passed through a 2mm-mesh sieve before they were subjected to laboratory analysis. The following physicochemical properties were determined; soil pH, soil organic matter, total nitrogen, available phosphorus, exchangeable bases (Ca, Mg, K and Na), exchangeable acidity, effective cation exchange (ECEC) and base saturation using established protocols as highlighted by (Udoh *et al.,* 2009) thus: Soil pH was determined by using digital electronic pH meter in water suspension of 1:2.5 soil: water ratio. Organic matter content was determined by Walkley and Black wet oxidation method (Nelson and Sommers, 1996). Total nitrogen was determined by the Macro-Kjeldahl digestion and distillation method. Available phosphorus was determined by the Bray P^{-I} extraction method and its concentration in the extraction was determined by the Blue colour method (Murphy and Riley, 1962).).Exchangeable cations (Ca, Mg, Na and K) were determined by $IMNH_4OAC$ extraction using EDTA titration method. Na and K were obtained using aflame photometer, while Mg and Ca were obtained using atomic absorption spectrophotometer (AAS). Particle size distribution was determined by the Bouyoucos hydrometer method after dispensing the soil sample with sodium hexametaphosphate (calgon) solution (Klute, 1986). Electrical conductivity was determined in a 1:2.5 soil: water extraction using a conductivity meter. Exchangeable acidity was determined by the KCl extraction method as outlined by (Agbede, 2017). Effective cation exchange capacity (ECEC) was determined by summing up the total exchangeable bases (TEB) and exchangeable acidity (EA). Base saturation was determined using the relationship BS = 100TEB/ECEC.

Results and Discussion:

The Physicochemical Properties: The status of the physiochemical properties of the soil before application of gramoxone herbicides is presented in Table1. The ratio of sand, silt and clay in the experimental soil were 72.84%, 8.74%, and 18.42% and the texture was loamy sand. Sand fraction was the dominant mechanical particle followed by silt and clay. The pH of the soil was strongly acidic (5.35). This is in line with the report of (Ekong and Uduak, 2015), who reported that the pH value of the soil of the areaanges from 5.20 to 5.40; signifying that it was strongly acidic. Available phosphorus was sufficiently (28.45) higher than the critical level of 12-15mg/Kg established by (FAO, 1976). The content of EC in the soil was 0.27ds/m. This was below the optimum value range of 0.6-1.8 established by (FAO, 1976) and used by (Gong, 2022). Total Nitrogen was low with the mean value 0.12g/Kg, which is lower than the critical limits of 1.5g/Kg (Ichikogu, 2011). Organic matter content falls within < 20g/kg and high within > 30g/kg proposed by (Aduayi *et al.* 2002). The order of abundance and bio-available of exchangeable bases for the soil was Ca > Mg > K > Na. The Ca content (2.88Cmol/kg) was lower than the 4Cmol/kg considered by (FAO, 197) as the critical value for fertile soil. The exchangeable Mg content (1.20Cmol/kg) in the soil was higher than 0.50Cmol/kg considered by (FAO, 1976) as the above critical value for fertile soil. The exchangeable K (0.50Cmol/kg) was high, and Na (0.08Cmol/kg) was below the critical level of 0.2Cmol/kg as reported by (Chude *et al..,* 2011) for soil of the humid tropical zone. The effective cation exchange capacity (ECEC) was 11.48Cmol/kg. This value was below the critical value 20Cmol/kg regarded by FAO (1976),to be favourable for crop production. The percentage base content in the soil was 46.40%, which also was below the critical limit of 50% for fertile soils.Soil texture:The mean sand fraction of the control plot was 82.49%, while the mean sand fraction of the plot applied with 3L/ha of gramoxone concentration was 72.84%. Plot applied with 4L/ha was 84.18% while plot applied with 5L/ha of gramoxone concentration was 78.78% (Tab.2). The plot applied with 4L of gramaxone per hectare (ha) was significantly difference ($p < 0.05$) in mean sand fraction than the controlled plot and those plots treated with 3L/ha and 5L/ha of gramoxone concentrations. The mean silt fraction of the controlled plot was 7.53%, while that of the plot applied with 3L/ha of gramoxone concentration was 8.74%. The plot applied with 4L/ha of gramoxone was 9.24% and that applied with 5L/ha of gramoxone concentration was 7.20%. There were no major differences among the treatments. The plot applied with 4L/ha of gramoxone was statistically higher in mean silt fraction than all other plots, including the control. The mean clay fraction of the control plot was 9.98%, the average clay fraction of the plot applied with 3L/ha of gramoxone concentration was18.42%, while the plot applied with 4L/ha was 10.34%, with the plot applied with 5L/ha of gramoxone concentration being 14.02%. The plot treated with 3L/ha was significantly difference ($p < 0.05$) in mean clay fraction than those plots treated with 4L/ha and 5L/ha of gramoxone concentrations including the control plot which had the maximum statistical value (Tab.2; Fig.1). The high silt and clay fractions of plots treated with 3 and 4L/ha of gramoxone herbicide could decrease the mobility of the particles in the soil (Hicks, 1990; Udoumoh *et al*., 2019), this could be ascribed to the surface area of silt and clay that enhances the binding of the herbicide to the soil

Effect Gramoxone Herbicide Applications on the Plant Height The application of the gramoxone herbicide increased the plant height of okra without any adverse effect relative to the control. At 2WAP, the highest plant height was recorded on the plot treated with 3L/ha (7.00) than the other plots, including the control. There was no significant difference ($p < 0.05$) between 3L/ha (7.00), 4L/ha (6.89) and 5L/ha (6.89), while the control (0L/ha) was the least significant (4.44). At 3WAP, the highest plant height was recorded on the plot treated with 3L/ha (7.8.67[a]). The same performance was recorded for week 4, 5, 6, and 7 respectively as 10.44[a], 11.83[a], 12.33[a] and 14.11[a] (Tab.3).

Soil pH: The mean soil pH of the control was 5.35, that of 3L/ha of gramoxone concentration was 5.40; that of 4L/ha was 5.25, while plot applied with 5L/ha was 5.28. There were no significant differences ($p < 0.05$) among the treatment plots. The plot applied with 3L/ha of gramoxone was statistically higher in mean soil pH than all other plots including control (Tab.4). The slightly higher soil pH in soil treated with 3L/ha of gramoxone herbicide could be attributed to the rapid degradation of 3L/ha and an improved base content of the soil (Topp 2017).

Electrical conductivity (EC): Soil electrical conductivity is a measure of the capability of the soil water to transmit electricity (USDA-NRCS, 2014). The average electrical conductivity (EC) of the control plot was $0.27 dsm^{-1}$, of the plot applied with 3L/ha was $0.29 dSm^{-1}$, that of the plot applied with 4L/ha was $0.18 dSm^{-1}$, while the plot applied with 5L/ha was $0.19 dSm^{-1}$. There were no significant differences ($p < 0.05$) among plots; with 3L/ha plot had statistically higher mean soil electrical conductivity than all other plots, including the control. The high electrical conductivity of the plot with 3L/ha of gramoxone herbicide, which in turn adds soluble nutrients to the soil, thereby enhancing electrical conductivity (Thom *et al.,* 1997). According to Gong (2022), EC is a measure of soil salt content that affects the growth performance of plants through interference with soil processes as observed in this study.

Organic carbon: The mean soil organic carbon content of the control was 2.78g/kg, that of the plot with 3L/ha was 1.56g/kg, plot applied with 4L/ha was 3.25g/kg, while plot applied with 5L/ha was 2.11g/kg (Tab.4). There were significant differences ($p < 0.05$) between the mean treatments and the plot applied with 4L/ha was significantly higher in mean soil organic carbon content than all other plots including the control. The plot treated with 3L/ha of gramoxone had the least organic carbon compared to the others. This could be attributed to the rapid biodegradation of 3L/ha, resulting in the release of C and N into the soil for microorganism usage. This, according to Thom *et al*., (1997), enhances the rate of organic matter decomposition.

Total N: The mean soil total N content of the control was 0.12g/kg; that of the plot applied with 3L/ha was 0.07g/kg. Plot applied with 4L/ha was 0.14g/kg, while plot applied with 5L/ha was 0.12g/kg. There were significant differences ($p < 0.05$) among treatments. The plot applied with 4L/ha of gramoxone was significantly higher in mean soil total N content than all other plots, together with the control (Tab.4). This could be ascribed to the biodegradation of the herbicide and eventual release of N, which is a component of gramoxone (Thom *et al.,* 1997). This, however, was in disparity with the report of Tudararo-Aharobo and Ataikirul (2020), which reported that herbicides do not affect the nitrate content of the soil.

Available Phosphorus (P): The mean available P of the control was 28.45mg/kg, while that with 3L/ha was 36.02mg/kg, the plot applied with 4L/ha was 38.11mg/kg while plot applied with 5L/ha was 35.80mg/kg. There were significant differences ($p < 0.05$) between treatments. The plot applied with 4L/ha was significantly higher in mean available P content than all other plots, together with the control. This could be ascribed to biodegradation of the herbicide and eventual release of N, which according to Thom *et al.,* (1997), enhances soil biomass.

Exchangeable bases; Exchangeable Calcium (Ca): The mean exchangeable Ca of control (0) was 2.88Cmol/kg, while that of 3L/ha was 2.52cmol/kg. Plot applied with 4L/ha was 2.60Cmol/kg, while plot applied with 5L/ha was 2.80Cmol/kg. There were no significant differences ($p < 0.05$) among treatments. The exchangeable Ca content of the control plot was significantly higher than all other plots. This was not unconnected with the interaction of herbicides with SOM, which reduces the absorption rate of the chemicals in the soil (Gender, 2012).

Exchangeable Magnesium (Mg): The mean exchangeable Mg of control was 1.20Cmol/kg, that of 3L/ha was 0.94cmol/kg, and plot applied with 4L/ha was 1.10Cmol/kg, while plot applied with 5L/ha was 1.60Cmol/kg (Tab.4). There were significant differences ($p < 0.05$) among treatment. The plot applied with 4L/ha was significantly higher in mean exchangeable Mg content than all other plots, including the control. This agreed with the report of Sebiomo and Banjo (2020).), that exchangeable cations declined in gramoxone treated plots.

Exchangeable Sodium (Na): The mean exchangeable Na of control was 0.23Cmol/kg, while mean exchangeable Mg of plot applied with 3L/ha was 0.15cmol/kg; plot applied with 4L/ha was 0.22Cmol/kg, while plot applied with 5L/ha of was 0.19Cmol/kg (Tab.4). There were significant differences ($p < 0.05$) among the treatments while the plot applied with 3L/ha was significantly like that of 0L/ha compare to 4L/ha and 5L/ha plots (Hicks *et al.,* 2012).

Exchangeable Potassium (K): The mean exchangeable K of the control was 0.50Cmol/kg; that of 3L/ha was 0.38Cmol/kg, the plot applied with 4L/ha was 0.22Cmol/kg, while the plot applied with 5L/ha was 0.12Cmol/kg. There were no significant differences ($p < 0.05$) among treatments. The control plot was significantly higher in mean exchangeable K content than all other plots. The low exchangeable Ca and K of plots treated with gramoxone herbicide could be ascribed to the speedy biodegradation of the herbicides, which gives rise to the release of C and N into the soil for microorganisms' usage. This resulted in a speedy rate of organic after decomposition, resulting in low contents of Ca and Mg in soil (Thom *et al.,* 1997).

Exchangeable Acidity: The mean exchangeable acidity of the control was 6.57Cmol/kg, that of 3L/ha was 5.29Cmol/kg. Plot applied with 4L/ha was 5.84Cmol/kg, while plot applied with 5L/ha was 5.40Cmol/kg. There were no significant differences ($p < 0.05$) among the treatments. The control plot was significantly higher in mean exchangeable acidity content than all other plots. This implies that plots treated with gramoxone herbicide have low potential acidity as reported by (Thom *et al.,* 1997).

Effective Cation Exchange Capacity (ECEC): The mean ECEC of the control was 11.48Cmol/kg and that of 3L/ha was 7.70Cmol/kg. Plot applied with 4L/ha was 9.98Cmol/kg, while plot applied with 5L/ha was 10.14Cmol/kg. There were significant differences ($p < 0.05$) among treatments, while the control plot had significantly higher mean ECEC content than all other plots. This could be due to the binding of the herbicide to the exchange sites, which reduces the available sites for cations (Gold *et al.,* 1996).

Base Saturation: The mean base saturation of the control was 46.40% and that of 3L/ha was 41.33%. The plot with 4L/ha was 41.50% while that of 5L/ha was 46.70%. There was no significant difference ($p < 0.05$) among treatments. The plot applied with 5L/ha was significantly higher ($p < 0.05$) in mean base saturation than all other plots, including the control. This could be attributed to the rapid degradation of 3L/ha of gramoxone herbicide (Thom *et al.,* 1997), which in turn is based on the soil particles.

Effect of Application of Herbicide on the Soil and Germination Percentage of Okra The percentage emergence/germination of okra had no significant difference ($p \leq 0.05$) between the different rates of gramoxone herbicide application. At Day 4, the highest statistical percentage of emergence/germination (PEG) was recorded for the seed show non soil treated with 3L/ha (44.33%). There were no significant differences between 3L/ha (44.33%), 4L/ha (37.00%), 0L/ha control (29.6%), and 5L/ha was the least significant (22.00%). At Day 5, the highest significant percentage emergence/germination (PEG) was recorded at seed sown on soil treated with 3L/ha (70.33%). There were significant differences between the various treatments. At Day 6, the highest statistical percentage of emergence/germination (PEG) was also recorded at seeds sown on soil treated with 3L/ha (89.00%). There were significant differences between 3L/ha (89.00%), 4L/ha (78.00%), 5L/ha control (77.67%) and control (0L/ha) were with the least significant (67.00%) (Tab.5, Fig.1). This could be attributed to the rapid degradation of 3L/ha of gramoxone herbicide which sequentially bases to the soil by binding the herbicide to the exchange sites, thereby reducing the available sites for cation and sequentially add soluble salts to the soil; thus, enhancing electrical conductivity (Thom *et al.,* 1997). This implies that for optimum percentage germination, it is not needed to apply beyond 3L/ha in the okra farm. The application of gramoxone herbicide increased the plant height of okra without any adverse effect relative to the control. At 2WAP, the highest plant height was recorded on the plot treated with 3L/ha (7.00). There was no significant difference between the treatments ($p < 0.05$) between 3L/ha (7.00), 4L/ha (6.89), and 5L/ha (6.89), except that the control (4.44) was significantly different. At 3WAP, the highest plant height was recorded on the plot treated with 3L/ha (8.67). There were significant differences ($p < 0.05$) between 3L/ha (8.67), 4L/ha (8.56), 5L/ha (7.73), and the control (6.16) was the least significant value. At 4WAP, the highest plant height was recorded on the plot treated with 3L/ha (10.44). There were significant differences ($p < 0.05$) between 3L/ha (10.44), 4L/ha (9.50), 5L/ha (9.45), and the control, which was the least significant (7.44). At 5WAP, the highest height was recorded on the plot treated with 3L/ ha (11.83). There were significant differences ($p < 0.05$) between 3L/ha (11.83), 5L/ha (10.50), 4L/ha (10.22), and the control, which has the least significant value (8.22). At 6WAP, the highest plant height was recorded on the plot treated with 3L/ha (12.33) than the other plots, including control, showing a significant difference ($p<0.05$) of 5L/ha (11.50), 4L/ha (10.94), and the control (8.99). At 7WAP, the highest plant height was recorded on the plot treated with3L/ha (14.11) with a significant difference ($p < 0.05$) with the rest (Tab.6; Fig.3) (5L/ha (13.11), 4L/ha (12.56), and the control (10.56)). This could be attributed to the rapid biodegradation of 3L/ha, giving rises to the release of C and N into the soil for micro-organisms 'usage, resulting in a rapid rate of organic matter decomposition (Thom *et al.,* 1997). Besides the rapid degradation of 3L/ha, which improves the base content of the soil by enhancing the binding of the herbicide to the soil particles, which diminishes the particles 'mobility (Hicks *et al.,* 1990).The application of gramoxone herbicide increased the number of leaves of the okra without any adverse effect relative to the control. At 2WAP, the highest number of leaves were recorded on the plot treated with 3L/ha (5.10) and 4L/ha (3.00) where there were statistically and significantly the same as with the other plot including control (Tab.7, fig.4). There was no significant difference ($p < 0.05$) between 3L/ha (3.00), 4L/ha (3.00), 5L/ha (2.55) and the control (0L/ha) were with the least significant (2.14). At 3WAP, the highest number of leaves was recorded on the plot treated with 3L/ha (3.89), followed by 4L/ha (3.11), 5L/ha (2.88), and the control (0L/ha), was with the least significant (2.44). There were no significant differences ($p < 0.05$) among treatments. At 4WAP, the highest number of leaves was recorded on the plot treated with 3L/ha (3.89) and 4L/ha (3.89), where they were statistically and significantly the same as in the other plot, including the control. There was no significant difference ($p < 0.05$) between 3L/ha (3.89), 4L/ha (3.89), 5L/ha (3.77), and the control (0L/ha) was the least significant (3.44). At 5WAP, the highest number of leaves was the same (4.11) among the treatment excerpt the control (3.56). At 6WAP, the highest number of leaves were recorded on the plot treated with 3L/ha (4.33) than the other plots including without any significant differences ($p < 0.05$) between them (3L/ha (4.33), 4L/ha (4.01), 5L/ha (4.22) and the control (4.00). At 7WAP, the highest number of leaves were recorded on the plot treated with 5L/ha, 4.99) higher than the other plots including the control. There were no significant differences ($p < 0.05$) between 5L/ha (4.99), 3L/ha (4.78), 4L/ha (4.33) and the control (0L/ha) were with the least significant (4.30) (Tab.7; fig.5). This could be attributed to biodegradation of the gramoxone herbicide and eventual release of N which improves the soil biomass which is the component of gramoxone herbicide to the soil (Hicks *et al.,* 1990).

Table 1: Physicochemical Properties of the Soil before Application of Gramoxone Herbicides

Soil Parameters	Values
Soil depth(cm)	0-15
Sand (%)	82.49
Silt(%)	7.53
Clay(%)	9.98
Soil pH	5.35
EC(ds/m)	0.27
OM(g/Kg)	4.81
TN(g/Kg)	0.12
NaCl(mg/Kg)	28.45
Ca(cmol/Kg)	2.88
Mg(cmol/Kg)	1.20
K(cmol/Kg)	0.50
Na(cmol/Kg)	0.23
EA(cmol/Kg)	6.57
ECEC(cmol/Kg)	11.48
BS%	46.40

Table 2:The effects of Gramoxone herbicide on soil physical properties

Treatment/rates of Gramoxone herbicide	**SAND**	**SILT**	**CLAY**
Trt1 (control 0L/ha)	82.49^{ab}	7.53^{a}	9.98^{c}
Trt2 (3L/ha)	72.84^{b}	8.741	8.42^{a}
Trt3 (4L/ha)	84.18^{a}	9.24^{a}	10.34^{c}
Trt4 (5L/ha)	78.78^{ab}	7.20^{a}	14.02^{b}
LSD (p<0.05)	0.26	0.10	1.00

a,b,c,ab; means on the same row with different superscripts are significantly different (p>0.05)

Table 3: Effect of Gramoxone Herbicide Applications on the plant height

ROGH	**2WAP**	**3WAP**	**4WAP**	**5WAP**	**6WA**	**7WAP**
0L/ha	4.44^{a}	6.16^{a}	7.44^{a}	8.22^{a}	8.99^{a}	10.50^{a}
3L/ha	7.00^{a}	8.67^{a}	10.44^{a}	11.83^{a}	12.33^{a}	14.11^{a}
4L/ha	6.89^{a}	7.78^{a}	9.45	10.22^{a}	10.94^{a}	12.56^{a}
5L/ha	6.89^{a}	7.78^{a}	9.45^{a}	10.50^{a}	11.50^{a}	13.11^{a}
LSD (p≤ 0.05)	0.419	0.310	0.283	0.211	0.26	0.273

a,b,c,ab;Means on the same row followed by different superscripts are significantly (p<0.05) different. LSD=least significant difference. WAP = week after applicationROGH = Rates of Gramoxone herbicide application

Table 4: The effects of Gramoxone herbicide on Soil Chemical Properties

Parameters	**0L/ha**	**3L/ha**	**4L/ha**	**5L/ha**	**sig**
SoilpH	5.35^{a}	5.4^{a}	5.25^{a}	5.28^{a}	0.59
EC(g/kg)	0.27^{a}	0.29^{a}	0.18^{a}	0.19^{a}	0.18
Org.Carbon(g/kg)	2.78^{c}	1.56^{b}	3.25^{a}	2.11^{bc}	0.29
TotalN(g/kg)	0.12^{ab}	0.07^{b}	0.14^{a}	0.12^{ab}	0.38
Org. matter (g/kg)	4.81^{b}	2.69^{d}	5.62^{a}	3.62^{c}	1.00
Available P (mg/kg)	28.45^{b}	36.02^{c}	38.11^{a}	35.80^{c}	1.00
K(Cmol/kg)	0.50^{a}	0.38^{a}	0.22^{a}	0.15^{a}	0.11
Ca (Cmol/kg)	2.88^{a}	2.52^{a}	2.60^{a}	2.80^{a}	0.44
Mg (Cmol/kg)	1.20^{b}	0.94^{b}	1.10^{b}	1.60^{a}	1.00
Na (Cmol/kg)	0.23^{b}	0.15^{a}	0.22^{b}	0.19^{ab}	0.11
EA(Cmol/kg)	6.57^{a}	5.29^{a}	5.84^{a}	5.40^{a}	0.89
ECEC (Cmol/kg)	11.48^{a}	7.70^{b}	9.98^{b}	10.14^{b}	1.00
Base Saturation (%)	46.40^{a}	41.33^{a}	41.50^{a}	46.70^{a}	0.53

a,b,c,ab;Means on the same row followed by different superscripts are significantly (p<0.05) different. LSD=least significant difference.

Table5: Okra Emergence Percentage Influenced By Gramoxone Herbicide Application

Herbicide Application Rates (L/ha)(%)	**PGD6 (%)**	**PGD4**	**PGD5**
0L/ha	29.60^{a}	29.67^{a}	67.00^{a}
3L/ha	44.33^{a}	70.33^{a}	89.00^{a}
4L/ha	37.00^{a}	33.33^{a}	78.00^{a}
5L/ha	22.00^{a}	55.33^{a}	77.67^{a}
LSD (p≤ 0.05)	0.404	0.198	0.257^{a}

a,b,c,ab; Means on the same row followed by different superscripts are significantly (p<0.05) different, and those with the same are not significant. LSD=least significant difference, PGD1 mean percentage germination day 4, PGD2 means percentage germination day 5, PGD3 means percentage germination day

Table 6: Effect of Gramoxone Herbicide Applications on the Plant Height

ROGH	2WAP	3WAP	4WAP	5WAP	6WAP	7WAP
0L/ha	4.44[a]	6.16[a]	7.44[a]	8.22[a]	8.99[a]	10.50[a]
3L/ha	7.00[a]	8.67[a]	10.44[a]	11.83[a]	12.33[a]	14.11[a]
4L/ha	6.89[a]	7.78[a]	9.45[a]	0.22[a]	10.94[a]	12.56[a]
5L/ha	6.89[a]	7.78[a]	9.45[a]	10.50	11.50	13.11
LSD	0.419	0.310	0.283	0.211	0.268	0.273

a,b,c,ab; Means on the same row followed by different superscripts are significantly ($p<0.05$) different.LSD=least significant difference, WAP = week after application, ROGH =Rates of Gramoxone herbicide application

Table7: Effect of Gramoxone Herbicide Applications on the number of leaf

ROGH	2WAP	3WAP	4WAP	5WAP	6WAP	7WAP
0L/ha	2.14[a]	2.44[a]	3.44[a]	3.56[a]	4.00[a]	4.33[a]
3L/ha	3.00[a]	3.22[a]	3.89[a]	4.11[a]	4.33[a]	4.78[a]
4L/ha	3.00[a]	3.11[a]	3.89[a]	4.11[a]	4.01[a]	4.33[a]
5L/ha	2.55[a]	2.88[a]	3.77[a]	4.11[a]	4.22[a]	4.99[a]
LSD($p\leq .0.05$)	0.215	0.192	0.452	0.340	0.450	0.272

a,b,c,ab; Means on the same row followed by different superscripts are significantly ($p<0.05$) different. LSD=least significant difference WAP=week after application ROGH=Rates of Gramoxone herbicides application.

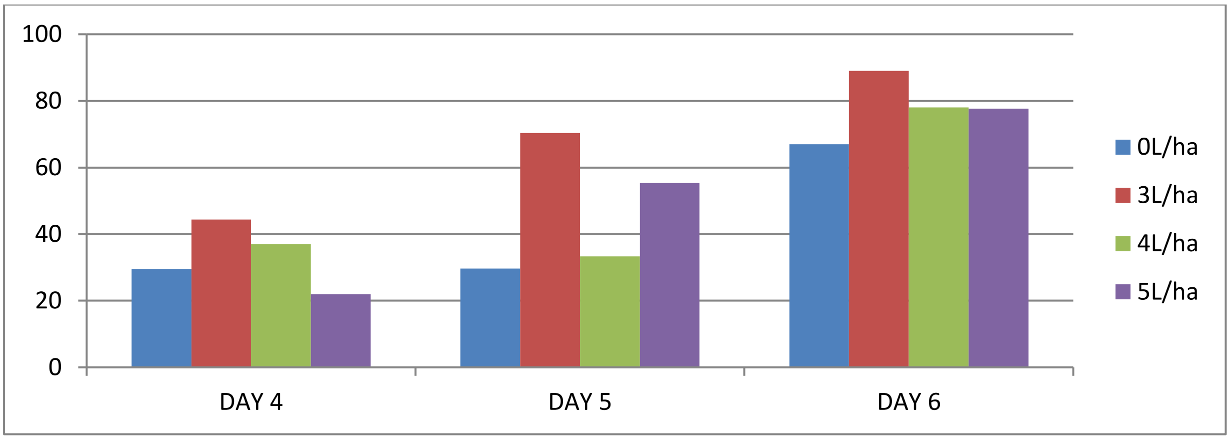


Figure 1: Percentage Germination of Okra

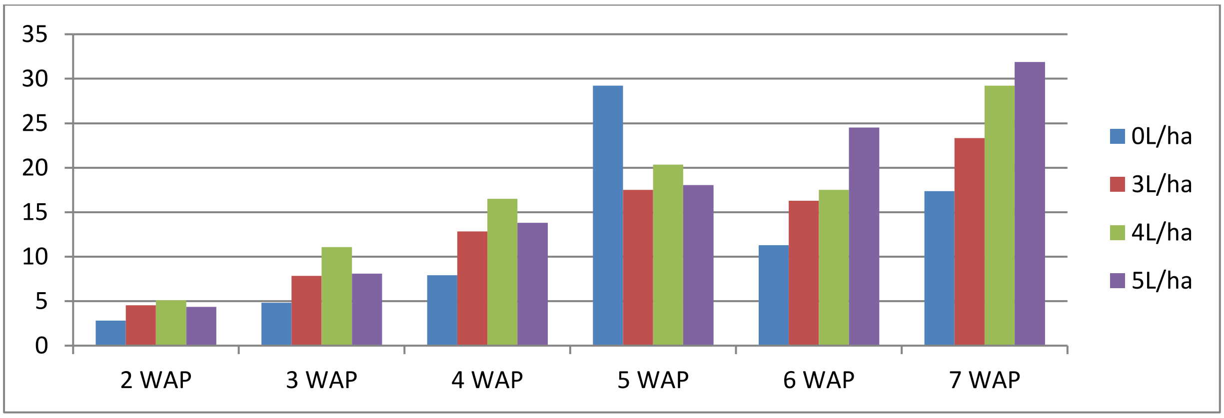


Figure 2: Leaf Area

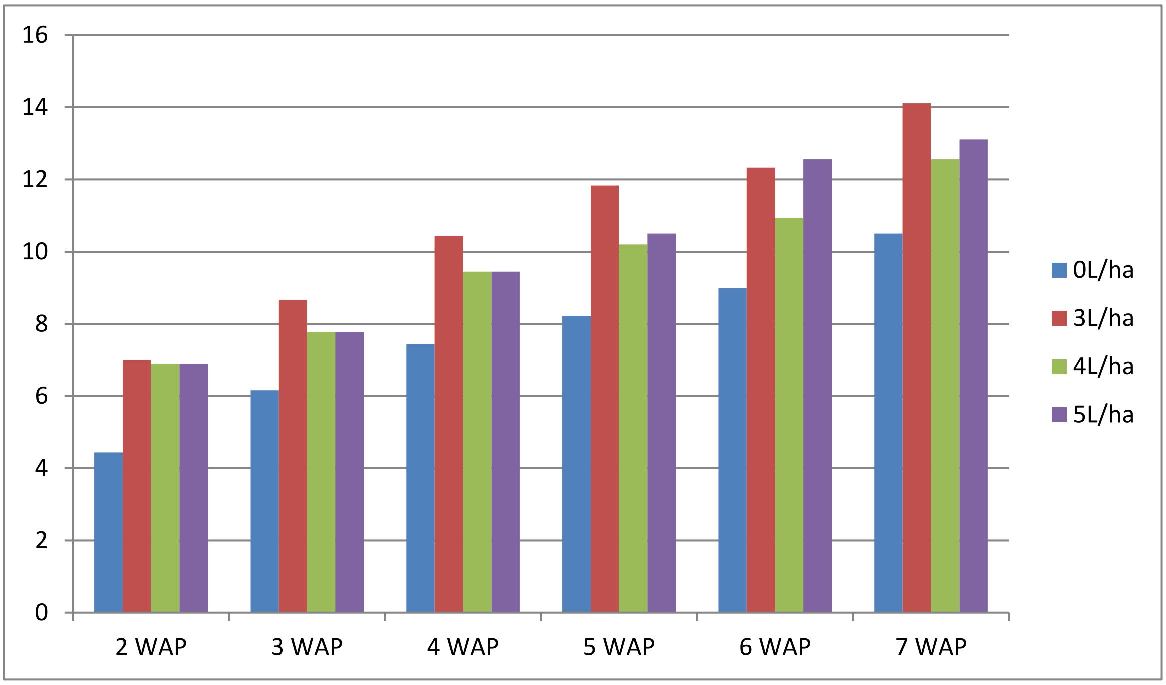


Fig3: Effect of Gramoxone Herbicide Applications on the Plant Height

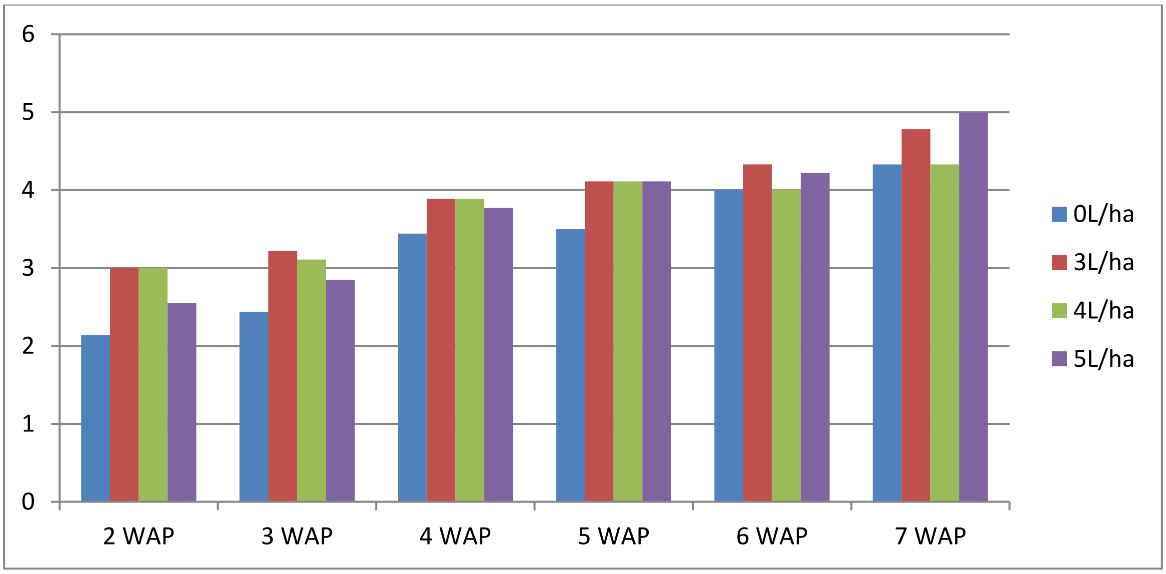


Figure 4: Effect of Gramoxone Herbicide Applications on the number of leaves

Conclusion:
The interactions between various rates of gramoxone herbicide applications to soil properties were significantly different from environmental indicators in the study area. The outcome ofthe experiment revealed that gramoxone herbicide at 3L/ha application gives more numbers of leaves at 2WAP, 3WAP, 4WAP, 5WAP, 6WAP and 7WAP compared to other rates. At this level of application, Gramoxone enhances rapid germination and increases plant height compared to the other levels of treatment. The interactive effect between okra and gramoxonein germination, number of leaves, and plant height parameters evaluated was significantly different, placing the use of it in an advantageous condition over the control (testcrop). Consequently, this study suggests the use of gramoxone herbicide should be encouraged among the locals in weed management; nevertheless, it should be used at the optimum rates of 3L/ha to suppress weed

development and encourage seed germination and sustainable vegetable production in the area.

REFERENCES

Aduayi, E. A., Chude, V. O., Adebusuyi, B. A and Olayiwola, S. O. (2002). *Fertilizer Use and Management Practices for Crop in Nigeria 3rdEd*. Produced by Federal Fertilizer Department, Federal Ministry of Agriculture and Rural Development, Abuja, Nigeria. Pp.23-73

Agbede, T. M. (2017) Impact of Poultry Manure and NPK Fertilizer on Soil Physical Properties and Growth and Yield of Carrot *Journal of Horticultural Research*, 2017, vol 25 (1): 81- 88DOI:10.1515/johr-2017-0009

Bassey, D. E., Udoumoh, I. D. J. and Akpanurom, K. (2019). Soil Microbial Population Associated with Different Land Use Types. *Nigerian Journal of Soil and Environment*. vol 17: 2018, 44-49

Beckie, H. J. (2011). Herbicide Resistant Weed Management. Focus on Glyphosate Pest Management Science (67) (9) 1637–1048. Bio-availability of Termicides to Subterranean Termites from five Soils.

Buzik, Shirley C., Schiefer H., BrunoI.and Donald, G. (1997). *Herbicides; Understanding their Benefits and Risks.* Boca Raton CRC Press

Chude, V. O., Malgwi, W. B., Amapu, I. Y., and Ano, A. O. (2011) *Manual on Soil Fertility Assessment. Federal Fertilizer Department in collaboration with National Programme for Food and Security*, Abuja - Nigeria. 62pp

Ekong, U. J and Uduak, I. G. (2015) Fertility Status of Soil at the Teaching and Research Farm of Akwa Ibom State University, Obio Akpa Campus, South-East Nigeria. *International Journal of Science and Research (IJSR)*

FAO, (1976). *World Reference Base for Soil Resources*, Food and Agricultural Organization of United Nations. Rome, p.112.

Gender, D., Lopez, R., Antello, J. Fiol, S. and Arce, F. (2012) Absorption of paraquat on soil organic matter: effect of exchamgeable cations and dissolved organic carbon. *Hazard Mater: Publ Med Advanced Use Guide DOI*:10.1016/j, jhazmat.2012.07.04

Gold, R. E., Howell, H. N., Pawson, B. M, Wright M S and Lutz J. L (1996) Persistence.

Gong, L. (2022) Soil Electrical Conductivity (EC): What ,is It, Why Important, How to Measure & More @www.seedstudio.com

Hicks, R.J., Stotzky, G.andVoris, P.V. (1990) Review and evaluation of the effects of xenobiotic Holt, J.S. (2013) *Encyclopedia of Biodiversity* (2nsd).Retrieved @ http/www.science direct, com 262

Ichikogu, V. I. (2011). Total Nitrogen and Available Phosphorus Dynamics in Soil Regenerating From Degraded Abandoned Rubber Plantation in Orogun Area of the Rainforest Zone of Southern Nigeria. *Ethopian Journal of Environmental Studies and Management* vol. 5 No.1.2012doi: http://dx.doi.org/10.4314/ejesm.v5i1.11

lores, Maya S., Cornez, Arroyo S., C alderon-Segura M. E., Villalobos, Pietrini R., Waliszewski S. and Gomez Dela Cruz L. Promutagen Activation of Triazine Herbicides Mietribuzin and Ametryn through Viciafaba Metabolism Induciry Sister Chromatid Exchanges in Human Lymphocytesin Vitroand in V.vaba Root Tip *Meristerus Toxicology in Vitro*. 2005, (9): 243–251.

Klute, R. (1986) Methods of Soil Analysis Part 1 Physical and Mineralogical Method. *American Society of Agronomy and Soil Science Society of America*, Madison, USA

Kole, R. K., Banerrjee, H., Bhattacharyya, A., Chowdhury, A. and Chaudhury, A (1999) Photo-Transformation of Some Pesticides. *Journal of Indian Chem Society*. 76; 593-800

Murphy, J. and Riley J. P. (1962). A Modified Single Solution Method for Determination of Phosphorus in Natural Waters. *Analytical Chem. Acta*. 27:31–36.

Nelson, D. W. and Sommers, L. E. (1996). Total Carbon, Organic Carbon and Organic Matter. Soil Science Society of America and American Society of Agronomy, 6775. Segoe Rd, Madison, WI.53711, USA. *Methods of Soil Analysis. Part3*. Chemical Methods– SSA Book Series, No.5

Omar, G. and Tasi^u, B. (2020) Effect of Herbicides Application on Soil Physicochemical Properties and Performance of Maize in Sudan Savanna Zone of Nigeria *International J. of Plant & Soil Science.* 2020, 3 2(2):47-58 Articleno.55110ISSN:2320-7035

Sebiomo, A. and Banjo, M. (2020). Determination of Exchangeable Cations and Residual Concentration of Herbicide Treated Soils and Analysis of the In-Vitro Biodegradation of the Herbicide *Idunas Natural & Applied Sciences* vol.3 No.248-63 DOI:10.38061/idunas.759008

Thom, E,,Ottow J. C. G. and Benckiser, G. (1997) Degradation of the fungicide difenoconazole in a silt loam soil as affected by pretreatment and organic amendement. *Environ Poll* 409–414.

Tudararo-Aharobo, L. E. and Ataikiru, T. L. (2020). Effects of Chronic Use of Herbicides on Soil Physicochemical and Microbiological Characteristics. *Microbiology Research Journal International* 30 (5):9-19 Articleno.MRJI56555 ISSN; 2456-7043.

Topp, E., Vallayes, T. and Soulas, G. (2017). Pesticides: Microbial Degradation and Effects. USGeological Survey (Estimated Agricultural Use for Paraquat) (2017).

Uduak, I. G., Udoumoh, I. D. J. and Ndubuisi-Nnaji, U. U. (2018). Selected Properties and Problems of Some Coastal Plain Soils in Akwa Ibom State. *Journal of Community and Communication Research* ISSN 2635-3318 vol.2 no 1 pp73-79

Udoh, E. J., Ibia, T. O., Ogunwale, J. A. Ano, A. O. and Esu. I. E. (2009). *Manual of Soil, Plant and Water Analysis* .Sibon Book Ltd. Lagos.

Udoumoh, I. D. J., Uduak, I. G. and Bassey, D. E. (2019) Effect of Gramoxone Herbicide on Soil Microbial Populaion at Obioakpa, Southeast Nigeria. *Journal of Agriculture, Environmental Resources and Manaagement*. ISSN 2245-1800 (paper) ISSN 2245-2943 (online)4(4)530-540

USDA-NRCS (2014) *Soil Electrical Conductivity Soil- Health Guide for Education*. United State Department of Agriculture; Natural Resources Conservation Service