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Journal of Ecology and Natural Resources
ISSN: 2578-4994

Growth and Yield of Maize (*Zea mays* L.) as Affected by Organic Soil Amendment in Rainforest Agro-Ecology

Agboola K[1]*, Lamidi K[2], Musa MA[2], Yusuf M[3] and Evinemi TO[4]

[1]Department of Soil and Environmental Management, Prince Abubakar Audu University, Nigeria

[2]Department of Crop Production, Prince Abubakar Audu University, Nigeria

[3]Department of Agricultural Technology, Kogi State Polytechnic, Nigeria

[4]Department of Aquaculture and Fisheries Technology, Federal University of Technology, Nigeria

Research Article

Volume 9 Issue 1

Received Date: December 27, 2024

Published Date: January 01, 2025

DOI: 10.23880/jenr-16000402

***Corresponding author:** Agboola K, Department of Soil and Environmental Management, Prince Abubakar Audu University, PMB 1008 Anyigba, Kogi State Nigeria, Email: kay.agboola.ka@gmail.com

Abstract

The field study was carried out to assess the Growth and Yield of Maize (*Zea mays* L.) as Influenced by Soil Organic Amendment in Rainforest Agro-Ecology The aim was to study the effects of Soil Organic Amendment on maize growth and yield. The experiment had eight (8) treatments (control, 10kg of humic acid per hectare, 20kg of humic acid per hectare, 30kg of humic acid per hectare, the recommended rate of NPK (900kg: 60kg: 60kg) per hectare, 1/3 of RNPK + 30kg of humic acid, 1/2 of RNPK + 30kg of humic acid and 2/3 of RNPK + 30kg of humic acid) which were replicated three (3) times and the experimental design was randomized complete block design (RCBD). From the result obtained, the application of Humic Acid on maize had no significant ($p>0.05$) influence on the plant height, number of leaves and stem girth for most of the sampling periods in both cropping seasons. However there were significant difference ($p>0.05$) for all the yield parameter tested except the cob diameter. The total yield of maize gotten in this study showed that treatment 60kgNPK/ha and HA_{30}+1/2RNPK had the highest yield were statistically at par in the first (6.13 and 5.74 t/ha) and Second (7.56 and 7.38 t/ha) cropping season respectively. Therefore, application of 1/2 fraction of the recommended mineral fertilizer rate in combination with HA (1/2 RNPK + HA_{30}) can be considered for optimum maize yield in the Study location for agriculture to be sustainable.

Keywords: Humic Acid; Soil Structure; Mineral Fertilizer; Growth and Yield

Introduction

Land degradation and desertification have reduced soil productivity. To achieve sustainable agricultural development, various organic amendments have been proposed to improve soil quality and productivity [1]. Applying organic amendments provides a management strategy to offset the reduction of soil organic carbon and reduce land degradation [2].

The introduction of various organic amendments is also considered as a means to improve soil structure and fertility, microbial activity, crop yield, and carbon sequestration to mitigate climate change [3]. Therefore, understanding the performance of variable organic modifiers under different conditions is essential for their proper application [4]. Research on the application of organic amendments such as fertilizers, biosolids, green waste, compost and biochar to agricultural soil improves soil fertility and soil health, sequesters carbon in the soil and, due to its potential, and reduces carbon dioxide emissions. Reduces greenhouse gas emissions and regenerative agriculture [5]. Humic substances (HS) are composed of humic acids (HA), fulvic acids (FA) and humic matter (HM), and are derived from biochemical transformations of educts of soil organic matter. The application of HS is vital for improving soil conditions and increasing plant nutrient uptake and growth, especially in soils with low organic matter contents [6]. Several studies have reported the role of HS in enhancing P availability and as a bio stimulant for plant growth [7]. Although HS was applied and evaluated for use in the environment and agriculture from the earliest days, in our opinion, there is still no general understanding of how HS affects the level of bioavailable P in soil.

The reduction of land per capita and the deterioration of soil quality help to increase the use of synthetic fertilizers in agricultural lands. However, the fertilization intensification of the last decades aimed to increase yields has produced some new global environmental and geopolitical problems, such as nutrient imbalances, leaching of nutrients from crops to environment and the associated impacts and increasing cost of fertilizers with serious geopolitical and economic problems for the food security in poor countries [8]. However, the use of artificial fertilizers alone is not a sustainable solution to improve soil fertility and maintain crop yield. In addition, excessive use of mineral fertilizers can cause soil acidification (e.g., ammonium nitrogen fertilizers), eutrophication (e.g., phosphorus fertilizers) and other environmental problems [9]. Therefore, the efficient use of organic amendments can be a sustainable means of improving soil quality and supplying nutrients to Maize (*Zea mays* L.) production in Rainforest Agro-Ecology

Materials and Methods

Experimental Land Area and Design

This research work was conducted in 2021 and 2022 in Ado-Ekiti, a tropical rainforest region of Nigeria. It is located at latitude $7^0 37'23''$ north and longitude $5^0 13'15''$ east with a height of 439 meters above sea level. The general climate is humid, with rainy and dry seasons. The average annual temperature is 27 degrees Celsius and the amount of precipitation is 160 mm. The total area of the test plot was 357.75 square meters (27 meters by 13.25 meters). The experiment was conducted in the form of a randomized complete block design with eight treatments and three replications. The treatments included control, 10 kg humic acid/ha, 20 kg humic acid/ha, 30 kg humic acid/ha, recommended rate of NPK (90 kg: 60 kg: 60 kg)/ha, 1/3 RNPK + 30 kg of it is It was composed of RNPK. Humic acid, RNPK 1/2 + humic acid 30 kg, and RNPK 2/3 + humic acid 30 kg. HA was used 2 weeks before planting to promote mineralization and mineral fertilizers were used 2 weeks after planting in a side-by-side method. Humic acid (brand name - Grand Hummus Plus) is imported and prepared by the personnel of this company in Nigeria.

Soil Analyses

Soil samples were collected before and after planting from a depth of 0 to 20 cm. Representative samples (25) were collected from the experimental fields and used together as a composite sample to represent the pre-planting sample, and at the end of the experiment, samples were taken from each sub-plot to represent the post-planting sample. To assess soil physical and chemical properties, samples were collected in labeled polyethylene bags using a soil auger, air-dried, ground, and sieved through a 2-mm mesh. Bulk density (BD) was obtained by kernel method [10]. The total porosity (TP) was obtained from the bulk density value and the particle density of 2.65 Mg^{-3} was taken as (TP) = [1-(bulk density/particle density)] × 100 [10]. Particle size distribution was measured by hydrometer method. Soil texture class was determined using texture triangles. The particle density of a soil sample is determined by measuring its mass after drying to a temperature of 105 degrees Celsius and then dividing that mass by the volume of the particles, excluding the spaces between the particles. Soil pH was measured using a glass electrode in soil water 1:1. Exchangeable bases (calcium, magnesium, potassium and sodium) were extracted using NH4OAC buffered to pH 7.0 [11]. Calcium and magnesium were measured using an atomic absorption spectrophotometer, and potassium and sodium were measured using a flame photometer. Exchangeable acidity (Al_3^+ and H^+) in soil was extracted with Kcl and determined by titration with 0.05 M NaOH using phenolphthalein as indicator. Total nitrogen of soil samples was determined by Macrojjeldahl method. Available phosphorus was determined by Bray-2 extraction method. Organic carbon content was determined using wet baking method [12].

Data Collection and Statistical Analysis

Data related to the effects of humic acids on the growth and yield of corn for plant height, stem girth and number of leaves at 2, 4, 6 and 8 weeks after planting for four plants were randomly selected. The height of the plant was measured by measuring the corn plant from the ground to the tip of the apical meristem of the main axis using the metric system. The number of leaves per plant was counted and averaged at 2, 4, 6 and 8 weeks after planting (WAP). The circumference of the stem was measured with a caliper. The number of cobs per plant was obtained by counting the number of cobs per labeled plant produced and recorded for each plot. We averaged plants per plot to obtain per-plant estimates. Collected biomass weight of fresh biomass (g), dry biomass (g), fresh cob (g) and dry cob (g) and other yield parameters (cob length, size (cm), cob diameter (cm) , and 100-grain weight (g) was also obtained using Statistical Tools of Agricultural Research (STAR, STAR). All data collected were subjected to analysis of variance (ANOVA) using the 2013 version, and treatment means were analyzed using Duncan's multiple range test (DMRT) were separated.

Results and Discussion

Humic Acid Concentrates

The results related to the humic acid concentrate used in this study are shown in figure 1. HA concentrate has a high pH of 10.07 (alkaline), a high proportion of humic acids (92%), 4.79% organic carbon and 0.24% total nitrogen. This is essential for high product performance. It is important to note that micronutrients are essential for plant growth and development. The analysis showed that HA contains a sufficient concentration of micronutrients required by agricultural products. Some authors reported that materials often considered as organic soil amendments should not contain heavy metals [13]. The results show that the HA concentrate contains 0% of the specific heavy metals analyzed, which makes it suitable as an organic soil amendment. Higher nutrient components of the humic acid amendment used in this experiment may have obviously contributed to the higher performance of the crop in both years of the trials. Lguirati, et al. [14] had reported that humic substances of compost substrate contain higher N and H than other sources. This is due to the incorporation of Nitrogen groups and polysaccharides-like structures engaged in higher microbial activities. Rizk, et al. [15] opined that humic substance are the most chemically active in the soils. Sonmez, et al. [16] obtained decrease in Nickel content due to higher metal content in commercially available humic acids (Table 1).

Chemical and Physical Properties of the Experimental Site before Planting

Table 2 shows the results of soil analysis before planting, chemical and physical properties of the experimental site before planting. The layer of texture is sandy loam soil and the soil is also acidic. Also, the results show that the concentration of nitrogen, soil organic carbon and available phosphorus is very low and makes the soil suitable for evaluating the effects of applied treatments on the growth and yield of corn. Salman, et al. [17] emphasized that humic acids increase crop yield, improve drainage and increase nutrients in most crops where soil nutrients are very low. Salim, et al. [18] added that potato nutrient uptake is often high when soil nutrients are conversely low.

Properties	Values
PH (H20)	10.07
% Organic carbon	4.79
% Total Nitrogen	0.235
% Carbon	36.48
% Oxygen	43.77
% Hydrogen	3.12
% Total Phosphorus	0.036
% Na	2
% K	3.65
% Ca	0.236
% Mg	0.068
% Sulpur	0.16
% Fulvic Acid	6.56
% Humic Acid	92
Mn (mg/kg)	14.4
Fe (mg/kg)	2,925.00
Cu (mg/kg)	5.6
Zn (mg/kg)	19.8
Chloride (mg/kg)	3678
Hg (mg/kg)	0
As (mg/kg)	0
Cr (mg/kg)	0
Pb (mg/kg)	0
Cd (mg/kg)	0
Surface area (g/cm^2)	1.567
Packed bulk density (g/m^3)	0.8635
Loose bulk density (g/m^3)	0.6752
C/N Ratio	1.00.01

Table 1: Humic Acid Concentrates.

Properties	Values
PH (H20)	6.97
PH (Cacl)	6.07
E.C	713
% Organic Carbon	2.46
% Total Nitrogen	0.271
Available P (mg/kg)	8.2
Exch. Acidity (cmol/kg)	0.3
Exch. H+ (cmol/kg)	0.28
Exch. A+++ (cmol/kg)	0.02
Ca (cmol/kg)	43.68
Mg (cmol/kg)	4.37
K (cmol/kg)	1.46
Na (cmol/kg)	1.17
CEC (cmol/kg)	50.98
Mn (mg/kg)	54
Fe (mg/kg)	61
Cu (mg/kg)	0.68
Zn (mg/kg)	1.12
Sand (%)	72.4
Silt (%)	16
Clay (%)	11.6
Textural Class	Sandy loam
Particle Density (g/cm^3)	2.65
Bulk Density (g/cm^3)	1.72
Porosity (%)	35

Figure 2: Chemical and Physical properties of the experimental site before planting.

As shown in Table 3, the results of the effect of HA on corn plant height showed that the application of HA on plant height in WAS2, 4 and 8 was not significant ($p<0.05$).

At 6 WAP treated with 20 kg/ha and 10 kg/ha, the control produced the shortest plants on average with 124.33 the tallest plants in 2021. 97.53 cm, but for the second year of 2022, HA application had no significant effect on plant height in WAP 2 and 4 ($p>0.05$), but it was significant in WAP 6 and 8 ($p<0.05$).

The sixth and eighth WAP treatments of 90 kg NPK/ha produced the tallest plants with averages of 111.97 and 155.34, while the shortest control plants were with averages of 89.17 cm and 120.78 cm, and an increase in plants in all treatments. was observed And this increase was shown statistically. It doesn't matter. The beneficial effects of humic acids on plant growth have been highlighted by several authors [19].

The increase in plant height obtained in both years is consistent with the report of Khan et al. (2019) obtained taller maize plants using 1.8 kg HA^{-1}. Similarly, taller plants have been obtained using humic acids from the stimulating effect of nitrogen released from soil due to humic acid activity [20].

The increase in plant height is because humic acid plays an important role in storing more nutrients necessary for plant growth, maintaining the buffering capacity and improving the intensity of plant growth.

Treatments	2021				2022			
	Weeks After Planting (WAP)				Weeks After Planting (WAP)			
	2	4	6	8	2	4	6	8
Control	12.8	50.8	97.53b	136.5	17	46	89.17c	120.78b
10kgHA/ha	13.1	62.1	124.33a	175.2	20.4	51.6	97.00abc	144.55ab
20kgHA/ha	14.8	56.7	124.33a	168.5	19.7	46.5	100.45abc	146.69a
30kgHA/ha	13	58.2	122.08ab	166.8	19.4	52.8	99.51abc	153.18a
90kgNPK/ha	16.1	61.8	120.33ab	180.8	19.9	54	111.97a	155.34a
HA30+1/3RNPK	15.7	60.3	116.67ab	171.6	18	45.4	94.08bc	141.88ab
HA30+1/2RNPK	16.5	58.2	112.08ab	168.2	21	51.6	108.78ab	153.51a
HA30+2/3RNPK	16.6	54	113.58ab	175.1	19.4	54.4	108.58ab	148.89a
LSD (0.05%)	NS	NS	*	NS	NS	NS	*	*
CV (%)	12.7	13.1	7.37	10.94	10.3	6.38	5.68	6.04

Means with the same letter(s) are not statistically significant at 5% level of test
NS = not significant at 5% level of test
* = significant at 5% level of test
Table 3: Effect of Humic Acid on Maize Height (cm) in Ado-Ekiti during the 2021 and 2022 cropping Season.

From the results of the effect of HA on the number of leaves shown in Table 4 below, the application of HA did not have a significant effect on the number of leaves at 2, 4 and 8 WAP ($p>0.05$), but there was a significant ($p<0.05$) 6 WAP with HA30+2/3RNPK treatment produced the most leaves. On the other hand, the control had the lowest number of leaves with an average of 7.92 in 2021. However, for the second year of 2022, HA application had no significant effect on leaf number at 2 and 4 WAP ($p<0.05$), but it was significant at 6 and 8 WAS ($p<0.05$). With six WAS treatments, HA30+2.3RNPK produced the most leaves with an average of 12.25, while the control had the least number of leaves with an average of 11.17. In the 8 WAS treatment, HA30+1.2RNPK had the most leaves with an average of 14.67 and the lowest number of leaves in the control treatment with an average of 13.33. Although an increase was observed in all plants in all treatments, this increase was not statistically significant. Our results are consistent reported that application of humic acid increased the number of leaves. Alfiati [21] noticed a significant reduction in the number of leaves produced in two maize cultivars as a result of a reduction in the photosynthetic activity of the plants, i.e. a reduction in humic acids. Seibel, et al. [22] showed that improving nutrient uptake, especially nitrogen, through the use of humic acids often affects leaf production, increases leaf chlorophyll concentration, and leads to overall shoot growth and development [23]. This issue has been confirmed by Rizvan et al. They emphasized that N, an essential component of plant chlorophyll tissue, promotes vegetative growth [24], leaf production and leaf area in maize crops [25].

Treatments	2021				2022			
	Weeks After Planting (WAP)				Weeks After Planting (WAP)			
	2	4	6	8	2	4	6	8
Control	4.3	6.8	7.92b	11.1	4.3	7.8	11.17b	13.33b
10kgHA/ha	4.3	7.1	9.25ab	13	4.8	8.9	11.75ab	13.92ab
20kgHA/ha	4.3	7.1	9.25ab	13.2	4.4	8.4	11.50ab	14.00ab
30kgHA/ha	4.8	6.8	8.83ab	12.8	4.4	8.7	11.67ab	14.42ab
90kgNPK/ha	4.5	6.8	9.33ab	13.6	4.7	8.9	12.17a	14.50ab
HA30+1/3RNPK	4.8	7.1	8.58ab	12.8	4.4	8.1	11.50ab	13.83ab

HA30+1/2RNPK	4.5	7.3	8.83ab	12.5	4.6	8.8	11.67ab	14.67a
HA30+2/3RNPK	4.6	7.2	9.80a	13	4.8	9.1	12.25a	14.58ab
LSD (0.05%)	NS	NS	*	NS	NS	NS	*	*
CV (%)	5.2	7.9	5.77	7.3	5.8	6.3	2.44	3.07

Means with the same letter(s) are not statistically significant at 5% level of test.
NS = not significant at 5% level of test
* = significant at 5% level of test
Table 4: Effect of Humic Acid on number of leaves per maize plant in Ado-Ekiti (2021 and 2022 Rainy Season).

As shown in Table 5 below, the results of the effect of HA on corn stalk environment show that the application of HA had a significant effect on the stalk environment in WAP 2, 4, 6 and 8 WAP in 2021.). In the second year of 2022, HA application had no significant effect on plant height at 2 WAP ($p<0.05$), but it had a significant effect. ($p<0.05$) at 4, 6, and 8 WAP. With the four WAS treatments, acid HA30+1/2RNPK produced the most wild-type stems with an average value of 1.33, while the control produced the least with an average value of 1.12. Treatments 6 and 8 WAP 90 kg NPK/ha produced the most wild rounds with means of 2.33 and 2.53, while the smallest were in the control with means of 1.95 and 2.00, with all plants across treatments, but this increase was statistically It is not meaningful. Significant effects of humic acids on the stem environment have been reported by several authors. Fan, et al. [26] reported improved stem girth and stem growth in wheat. Eyheraguibel, et al. [27] also added that humic acids improved root, leaf and shoot growth. As reported by Mahmoud, et al. [28], branch and stem girth was increased in plots treated with HA both in soil and as foliar application compared to control plots. This improvement can be the result of fast absorption of nitrogen, optimal photosynthetic rate, longer duration of the leaf surface and intense accumulation of nitrogen in the shoot, which in turn was the result of this experiment, which was reflected in the maximum growth and development of the shoots during the period.

Treatments	2021				2022			
	Weeks After Planting (WAP)				Weeks After Planting (WAP)			
	2	4	6	8	2	4	6	8
Control	0.4	1.06	1.4	1.8	0.5	1.12ab	1.95b	2.00b
10kgHA/ha	0.5	1.23	1.6	2.1	0.5	1.27ab	2.03ab	2.22ab
20kgHA/ha	0.4	1.15	1.7	2	0.5	1.14ab	2.12ab	2.22ab
30kgHA/ha	0.5	1.16	1.7	2.1	0.5	1.17ab	2.17ab	2.19ab
90kgNPK/ha	0.5	1.31	1.9	2	0.5	1.25ab	2.33a	2.53a
HA30+1/3RNPK	0.5	1.22	1.6	2	0.5	1.06b	2.04ab	2.09b
HA30+1/2RNPK	0.5	1.31	1.7	2	0.5	1.33a	2.09ab	2.19ab
HA30+2/3RNPK	0.5	1.16	1.7	2.1	0.5	1.29a	2.17ab	2.33ab
LSD (0.05%)	NS	NS	NS	NS	NS	*	*	*
CV (%)	7.4	12.1	8.1	6	6	6.26	4.71	5.61

Means with the same letter(s) are not statistically significant at 5% level of test
NS = not significant at 5% level of test
* = significant at 5% level of test
Table 5: Effect of Humic Acid on maize stem girth in Ado-Ekiti (2021 and 2022 Rainy Season).

As shown in Table 6, HA amendment had a significant effect ($p<0.05$) on the performance characteristics of Ado-Ekiti Maze in both years of the experiment. Maximum fresh biomass weight (498.33 g), dry biomass weight (144.17 g), fresh cob weight (290.00 g) and dry cob weight (168.33 g) obtained from plots treated with 90 kg NPK/ha in 2021 came performance comparable to that obtained from HA30+2/3RNPK-treated slices. The lowest yields of these parameters (289.17 g, 75.83 g, 224.00 g, 115.50 g) were consistently obtained from the control plots. Other treatments were not significantly different in terms of performance. In 2022, fresh biomass yield was not significantly affected by HA amendment (p>0.05). However, the highest dry biomass weight (239.50 g), fresh cob weight (405.08 g) and dry cob weight (232.17 g) were obtained from HA30+1/2RNPK treated plots. Other treatments provided comparable yields. Similarly, the lowest yields (121.08 g, 267.58 g and 142.58 g) were consistently obtained in the control plots. The optimal yield for fresh biomass, dry biomass, fresh cob and dry cob obtained from the application of 90 kg of NPK per hectare is consistent with the report of Nasiral-Islami, et al. [29] reported that application of 150 kg/ha of urea significantly improved spike number, biomass and yield of wheat. Our results are also consistent with the results of Ahma, et al. [30]. Some other authors have obtained the best performance characteristics by using 100% NPK fertilizer in addition to humic acid. As reported by Sangeetha, et al. [31] the highest yield was obtained with 100% NPK and 20 kg HA^{-1} as soil application. Mekuannet, et al. [32] improved maize biomass and grain yield by applying 130.5 kg N/ha in Haramaya, eastern Ethiopia. Similarly, our results for 2022 show that the application of 20 kg/ha HA + NPK at 100% of the recommended dose resulted in the highest grain yield and the highest uptake of N, P and K, which is consistent with the results of Sivkumar, et al. [34] rice Mekuannet, et al. [32] used a mixture of NPS and N fertilizer to increase above ground maize biomass. Nikbakht reported that the application of Leonardite-derived HA in a greenhouse experiment increased root and shoot biomass of gerbera and canola, respectively. The improved yield obtained in this study when using HA and NPK fertilizers in combination indicates that HA and mineral fertilizers form a complex complex and slowly release nutrients for effective crop uptake [34].

Treatment	2021				2022			
	F. B	D.B	F.C	D.C	F. B	D.B	F.C	D.C
Control	289.17e	75.83f	224.00b	115.50b	443.1	121.08c	267.58b	142.58b
10kgHA/ha	320.90de	95.00e	255.83ab	147.17a	578.1	182.67ab	333.67ab	174.58ab
20kgHA/ha	369.17cd	106.67de	248.33ab	153.67a	632.7	195.00ab	330.42ab	219.17a
30kgHA/ha	384.17bcd	112.50cd	283.50ab	161.33a	608.4	194.42ab	340.75ab	208.50a
90kgNPK/ha	498.33a	144.17a	290.00a	168.33a	792.3	229.08a	394.83ab	235.92a
HA30+1/3RNPK	400.00bc	118.33bcd	260.83ab	145.83a	541.6	150.50bc	295.25ab	174.17ab
HA30+1/2RNPK	429.17bc	121.67bc	303.33a	166.67a	749.2	239.50a	405.08a	232.17a
HA30+2/3RNPK	445.00ab	130.00b	276.67ab	165.33a	633.3	198.08ab	385.25ab	227.42a
LSD (0.05%)	*	*	*	*	ns	*	*	*
CV (%)	9.02	6.97	8.25	6.15	14.85	17.12	13.53	10.71

Means with the same letter(s) are not statistically significant at 5% level of test
* = significant at 5% level of test
F.B = fresh biomass (g), D.B = dry biomass (g), F.C = fresh cob (g), D.R = dry cob (g)
Table 6: Response of maize yield parameters to humic acid application in Ado-Ekiti (2021 and 2022 Rainy Season).

As shown in Table 7, HA amendment had a significant effect (p<0.05) on maze performance characteristics and yield in Ado-Ekiti in both years of the study. Application of 90 kg NPK/ha resulted in maximum ear length (18.71 cm), ear diameter (4.36 cm), 100 seed weight (24.67 cm) and seed weight (yield)/ha of 6.13 tons in 2021. length 19.7 cm, ear diameter 4.79 cm, 100-seed weight 26.67 cm and seed yield 7.57 t/ha in 2022. This result is in agreement with the yield obtained from plots treated with HA30+1/2RNPK and HA30+2/3RNPK. It was comparable. Other treatments were comparable. However, the control plot consistently had the lowest results in both years of the experiment. Our results are consistent with several reports that characterize the overall response of maize to soil organic amendments and mineral fertilizers [35]. El Makser, et al. [36] reported that the use of humic acid increased the number of sinks produced and improved nutrient absorption, and thus improved biomass production, weight and length of spike. Khan, et al. [20] also showed that the incorporation of humic acid and nitrogen significantly increased the number of ears per square meter, 1000-grain weight, spike length, spike 1 plant, shoot yield and maximum grain yield in corn cultivars: Iqbal's findings [37]. The significant increase in yield characteristics and seed yield from 2021 to 2022 obtained in this study indicates the sufficient supply of nitrogen during the reproductive stage of the crop [38], which may have accelerated the rate of photosynthesis [39] and the ability to label corn products [40]. Similarly, humic acids may better improve soil physical and chemical microclimate and allow increased yield and biomass production by improving plant biochemistry, physiology and productivity [41-45].

Treatment	2021				2022			
	CL	CD	100SW	Yield (t/ha)	CL	CD	100SW	Yield (t/ha)
Control	14.98b	3.88b	20.33b	2.66d	15.77b	4.25b	23.00c	4.43b
10kgHA/ha	16.57ab	4.05ab	22.67ab	3.52c	18.01ab	4.48ab	26.00abc	6.17a
20kgHA/ha	16.90ab	4.26ab	24.00ab	4.53b	18.15ab	4.51ab	26.33abc	6.25a
30kgHA/ha	17.26ab	4.30ab	23.67ab	4.61b	16.97ab	4.68a	26.33abc	6.64a
90kgNPK/ha	18.71a	4.36a	24.67a	6.13a	19.70a	4.79a	26.67abc	7.57a
HA30+1/3RNPK	17.13ab	4.24ab	22.00ab	5.06b	17.20ab	4.42ab	24.33bc	6.15a
HA30+1/2RNPK	18.35a	4.30ab	24.00ab	5.74a	19.28a	4.77a	28.67a	7.38a
HA30+2/3RNPK	17.98a	4.28ab	25.00a	5.64a	17.39ab	4.59ab	27.33ab	7.02a
LSD (0.05%)	*	*	*	*	*	*	*	*
CV (%)	4.99	3.75	5.8	6.99	6.21	3.19	5.46	13.58

Means with the same letter(s) are not statistically significant at 5% level of test
* = significant at 5% level of test
C.L = cob length (cm), C.D = cob diameter (cm), 100SW = 100-seeds weight (g)
Table 7: Response of maize yield parameters (continued) to humic acid application in Ado-Ekiti (2021 and 2022 Rainy Season).

Conclusion and Recommendation

The results of the experiment showed that maize responded well to treatment with 90 kg NPK/ha and HA30 + 1/2 RNPK in measured growth and yield parameters. Addition of 1/2 of recommended mineral fertilizer in addition to humic acid proved to be the best HA loading rate in terms of maize yield in both cropping seasons. This yield is statistically equivalent to the yield obtained when the recommended mineral fertilizer rate was applied at the study site. To reduce the problems associated with excessive mineral fertilizer application, treatment – HA30 + 1/2 RNPK can be recommended for best maize production in the study area. Further studies are needed to determine the optimum level of sole humic acid application rate for maize yield at the study location.

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