International Journal of Applied Sciences & Engineering

www.ijapscengr.com | ISSN 2308-5088 | editor@ijapscengr.com

RESEARCH ARTICLE

Assessing How Different Soil Treatments Affect Crop Yield in Southeast Nigeria

Orakwe LC[1], Nwachukwu CP[2*] and Anizoba DC[3]

[1,2,3]Department of Agricultural and Bio-resources Engineering, Nnamdi Azikiwe University, Awka, Nigeria

ARTICLE INFO

Received: January 02, 2023
Revised: February 20, 2023
Accepted: March 04, 2023

Key words:
Tillage
NPK Application Rate
Management Allowable Depletion
Irrigation

***Corresponding Address:**
cp.nwachukwu@unizik.edu.ng

ABSTRACT

This study used the Oba Super 13 maize variety as a test crop on three main plots, each of which represented a distinct tillage technique, in order to explore the impact of various soil treatments on crop output. There are a total of 27 subplots, three levels of each of the three soil treatments (irrigation deficit, tillage method and NPK Application rate) present in each plot. All of the subplots' crop yields were calculated, and the conservative tillage method with 10% MAD and 600 kg/ha NPK application rate produced the highest crop yield of 2540 kg/ha, while; no tillage, 50% MAD and 400 kg/ha NPK application rate produced the lowest yield of 1234.67 kg/ha. All of the subplots' controllable variables were optimized utilizing the response surface technique (RSM). The best values based on the run resulted in a crop yield of 2543.589Kg/Ha, conservative tillage, an irrigation deficit of 11.594%, and NPK application rates of 596.406Kg/Ha. For the purposes of this study, conservative tillage produced the highest maize yield. This supports the idea that a drip irrigation system could produce a high yield in the research area.

Cite This Article as: Orakwe LC, Nwachukwu CP, Anizoba DC, 2023. Assessing how different soil treatments affect crop yield in southeast Nigeria. Inter J Appl Sci Engr, 10(2): 39-45. www.ijapscengr.com

INTRODUCTION

Kang *et al.* (2009) state that one of the concerns to crop productivity and food security is the availability of water for agriculture on a worldwide scale (2009). In sub-Saharan Africa, only 4% of the total arable land is currently irrigated, according to the ACPC Report (2011). This suggests that most agriculture is rain-fed, rendering the industry particularly sensitive to the whims of climate variability and change. According to Mendelson *et al.* (2008), agriculture continues to be the primary source of employment and GNP in the majority of African countries, but it is threatened by climate change and variability. In general, climate change and variability have created significant obstacles to South Eastern Nigeria's sustainable development, including agricultural practices and farming systems.

Climate change, according to Anyadike (2009), is when a change in climate condition persists in one direction, moves quickly, and lasts for an unusually long time. Additionally, according to IPCC (2009), it is also defined as statistically significant alterations that last for a long time, generally decades or longer, and it encompasses changes in the frequency and intensity of sporadic weather events as well as the gradual, ongoing rise in temperature. Variations in several climate parameters, such as temperature and precipitation, cause these changes.

Eboh (2009) asserts that there are various ways in which climate change can manifest, including changes in average climate conditions, where some regions experience average increases in precipitation or decreases in it and changes in climate variability, where precipitation events become more unpredictable. Additionally, Ozor (2009) noted that it is pertinent that agricultural productivity under these conditions will be very low given the rising rates of drought, unpredictable rainfall, pest and disease outbreaks, erosion, flooding, bush burning, and other environmental issues. The low yield will affect the price of commodities, the profitability of farming, the affordability of food, and the security of the food supply.

As a result, it is crucial to construct sustainable dry season farming in southern Nigeria through irrigation that will provide the necessary amount of water in both quantity and quality, with drip irrigation being the most advantageous for water management goals.

Acknowledgements: The Tertiary Education Trust Fund, (TET Fund), provided an Institution Based Research, (IBR) grant to support this research, for which the authors are extremely grateful.

MATERIALS AND METHODS

Study Area

The Department of Agricultural and Bioresources Engineering Experimental Site/Farm Workshop at Nnamdi Azikiwe University in Awka, which is located between latitudes 6°15'11.8N and 6°15'5.3E and longitudes 7°7'118N and 7°7'183N and has an elevation of 142m, was the site of the field experiment. Previous research determined that the region's soil is a sandy loam that is often found in savannas covered with grass and formed by the Imo shale (Aghamelu *et al.* 2012). The Anambra River and its tributaries are the main rivers that drain the region, and there are two main climatic seasons: the dry season, which lasts from November to March, and the rainy season, which lasts from April to October but has less rain in August (the "August break").

While the temperature during the rainy season ranges from 16 to 28°C, the temperature during the dry season ranges from 20 to 38°C, increasing evapotranspiration. In the period from January 2022 to April 2022, the experiment was carried out.

Materials and Tools

The experiment's materials comprised 25mm, 19mm, and 12.5mm PVC pipes for the main lines, laterals, and sub mains, respectively. They also included a 2mm drill machine, a 19mm end cap, a 25mm by 12.5mm bend, a 12.5mm by 19mm inch bend, 25mm ball gauges, and 12.5mm and 25mm ball gauges. Design Expert 11 software, a pressure gauge, a moisture meter, a storage tank, a block stand, a leveling tool, a measuring cylinder, a tractor, collection cans, and a pressure plate apparatus were all part of the equipment.

Field Preparation

The field was prepared by splitting the area into three primary portions, each measuring 27 m x 27 m. The field is level. Section A received conventional tillage, which involved thorough tilling with a plough and harrow; section B received conservative tillage, which involved one tractor pass; and section C did not get any tillage. To achieve level ground, the areas mapped out were leveled.

Field Setup

The experiment was set up using a central composite design (CCD), with three plots and nine sub-plots each in the experimental field. The following was done for the experimental design: Tillage techniques (conventional tillage, where the land was thoroughly tilled with a plough and harrow; conservative tillage, where the land was not tilled at all; zero tillage, where there was no tillage); irrigation deficit levels (50% MAD, 30% MAD, and 10% MAD); and NPK fertilizer application rates (450 kg/ha, 550 kg/ha and 650 kg/ha).

Each of the 27 sub-plots that made up the experimental plot measured 3m X 3m. As the main line, sub-main, and laterals, 25mm, 19mm and 12.5mm PVC pipes, respectively, were utilized. The laterals were spaced at intervals of 0.5m, and holes were perforated on the laterals at intervals of 0.45m to function as emitters. As a result, the crop spacing was 0.5m X 0.45m. All other required procedures, such as weed and pest management, were carried out in accordance with accepted local customs and guidelines.

The Test Crop

OBA SUPER 13 Zea mays hybrid was the crop used in the experiment and Table 2.1 lists the time frame and growth phases.

Table 2.1: Length of time for each growth stage.

Growth stages	Duration (days)	Period
Initial stage	14	January 27 to February10
Crop development stage	24	February 11 to March6
Mild stage	27	March 7 to April 3
Late stage	20	April 4 to April 24

Table 2.2: Independent variables and levels applied to the design of the response surface

Independent variables	Symbols	Ranges and levels		
		-1	0	+1
Irrigation Deficit (%)	A	10	30	50
NPK Aplication rate (KG/HA)	B	400	500	600
Tillage	C	1	2	3

Drip Irrigation System

From the overhead tank to the field layout, where they were joined to the sub mains by 19mm X 25mm tees, the 25mm PVC pipes were used as the main line. With all required accessories, 19mm by 12.5mm tees were used to connect the laterals to the sub mains. Using a pressure plate apparatus, the permanent wilting point (PWP) of the soils was also determined at a pressure of -1.5Mpa along with the field capacity at a pressure of -0.01Mpa.

Yield Components

Five plants were randomly chosen from each plot for the cobs plant per cob (Cob-1) study, and the quantity of maize ears in each plant was tallied. Less than 5% of the regular ear's kernels were found in some ears, which were rejected. Three ears were randomly chosen from each subplot, and the quantity of kernels in each ear was counted to determine the grain per cob (Cob-1). The grain size weight in grams for 1000 seeds is expressed as the "1000-grain weight." Randomly chosen maize ears were taken from each subplot, and each subplot had 1,000 grains counted and weighed.

Cob weights were calculated as the average weight values of randomly chosen cobs from each subplot, whilst cob thickness was calculated as the average of randomly chosen cobs from each subplot and recorded. The components of the yield were used to calculate the grain yield.

Parameters for Experimental Design and Optimization

Utilizing the Response Surface Methodology (RSM), it was used to determine how irrigation deficit, NPK fertilizer application, and tillage affected crop yield. Table 2.2 displays the values for the primary composite design. A, B, and C, respectively, were used to represent the research variables irrigation deficit (%), NPK Application rate (Kg/Ha), and tillage.

Response Surface Methodology (RSM) was used to statistically assess the experimental data acquired from the

Table 3.1: Grain Cob^{-1}

	Conventional Tillage	Conservative Tillage	No Tillage
10% MAD/600Kg NPK	504	594g	467g
10% MAD/500Kg NPK	503	591g	467g
10% MAD/400Kg NPK	501	577g	461g
	Conventional Tillage	Conservative Tillage	No Tillage
30% MAD/600Kg NPK	495	509	433
30% MAD/500Kg NPK	416	495	401
30% MAD/400Kg NPK	396	439	371
	Conventional Tillage	Conservative Tillage	No Tillage
50% MAD/600Kg NPK	453	471	409
50% MAD/500Kg NPK	433	450	391
50% MAD/400Kg NPK	390	410	351

Table 3.2: Result for 1000-Grain Weight

	Conventional Tillage	Conservative Tillage	No Tillage
10%MAD/600Kg/Ha NPK	324g	342g	245g
10% MAD/500Kg/HaNPK	280g	288g	190g
10% MAD/400Kg/Ha NPK	263.1g	271g	151.1g
	Conventional Tillage	Conservative Tillage	No Tillage
30% MAD/600Kg/Ha NPK	316g	316g	231g
30% MAD/500Kg/Ha NPK	296g	299g	219g
30% MAD/400Kg/Ha NPK	275g	279g	197g
	Conventional Tillage	Conservative Tillage	No Tillage
50% MAD/600Kg/Ha NPK	301g	295g	219g
50% MAD/500Kg/Ha NPK	290g	291g	196g
50% MAD/400Kg/Ha NPK	279g	279g	190g

Table 3.3: Cob Weight Results

	Conventional Tillage	Conservative Tillage	No Tillage
10% MAD/600kg/Ha NPK	406g	406g	370g
10% MAD/500kg/Ha NPK	397g	399g	370g
10% MAD/400Kg/Ha NPK	370g	391g	354g
	Conventional Tillage	Conservative Tillage	No Tillage
30% MAD/600Kg/Ha NPK	401g	405g	367g
30% MAD/500Kg/Ha NPK	397g	397g	361g
30% MAD/400Kg/Ha NPK	379g	390g	360g
	Conventional Tillage	Conservative Tillage	No Tillage
50% MAD/600Kg/Ha NPK	400g	405g	359g
50% MAD/500Kg/Ha NPK	395g	403g	351g
50% MAD/600Kg/Ha NPK	390g	395g	347g

Table 3.4: Crop Yield Results

	No Tillage (Kg/Ha)	Conservative Tillage (Kg/Ha)	Conventional Tillage (Kg/Ha)
10% MAD/600Kg/Ha NPK	1401.73	2540.09	2195.03
10% MAD/500Kg/Ha NPK	1390.36	2505.19	2059.64
10% MAD/400Kg/Ha NPK	1334.9	2345.24	1643.89
	Conventional Tillage	Conservative Tillage	No Tillage
30% MAD/600Kg/Ha NPK	1354.16	2475.1	1976.09
30% MAD/500Kg/Ha NPK	1323.7	2401.09	1904.57
30% MAD/400Kg/Ha NPK	1301.23	2395.19	1701.67
	Conventional Tillage (Kg/Ha)	Conservative Tillage (Kg/Ha)	No Tillage (Kg/Ha)
50% MAD/600Kg/Ha NPK	1301.34	2309.9	1860.49
50% MAD/500Kg/Ha NPK	1291.67	2345.24	1791.19
50% MAD/400Kg/Ha NPK	1234.67	2301.06	1506.91

central composite design, and a mathematical model based on a second order polynomial with interaction terms was utilized to generate the expected responses.

RESULTS AND DISCUSSION

Field Capacity

The results showed that no tillage recorded lowest field capacity (0.07cm3/cm3, 0.11cm3/cm3, 0.12cm3/cm3 and 0.14cm3/cm3 for soil depths 0-25cm, 25-50cm, 50-75cm and 75-100cm respectively). The values recorded in conservative tillage were (0.11cm3/cm3, 0.11cm3/cm3, 0.11cm3/cm3, and 0.14cm3/cm3 for 0-25cm, 25-50cm, 50-75cm and 75-100cm respectively), and conventional tillage (0.09cm3/cm3, 0.13cm3/cm3, 0.15cm3/cm3 and 0.17cm3/cm3 for 0-25cm, 25-50cm, 50-75cm and 75-100cm respectively. Conservative tillage had a higher value of field capacity at 0–25 cm soil depth than conventional tillage, which may be due to runoff that occurred in the top soil during conventional tillage since there was maximal soil disturbance, which was contrary to the finding reported by Alam *et al.* (2014). This is due to the clay loam soil type, where the maximum FC was found with no tillage (0.14 cm3/cm3), followed by conservative

Table 3.6: Sequential Model Sum of Squares for Crop Yield

Source	Sum of Squares	Df	Mean Square	F-value
Mean vs Total	9.330E+07	1	9.330E+07	
Linear vs Mean	5.483E+06	4	1.371E+06	169.81
2FI vs Linear	1.291E+05	5	25817.90	9.05
Quadratic vs 2FI	15019.15	2	7509.58	3.36
Cubic vs Quadratic	22533.64	8	2816.71	1.80
Residual	10961.18	7	1565.88	
Total	9.896E+07	27	3.665E+06	

Table 3.7: Analysis of Variance (ANOVA) for the Fitted Quadratic Model for Crop yield

Source of variables		Sum of Squares	df	Mean Square	F-value	p-value	
Model		5.645E+06	17	3.320E+05	182.70	< 0.0001	Significant
A-Irrigation deficit%		1.206E+05	1	1.206E+05	66.38	< 0.0001	
B-NPK Application rate		1.511E+05	1	1.511E+05	83.14	< 0.0001	
C-Tillage		5.212E+06	2	2.606E+06	1433.80	< 0.0001	
AB		12270.73	1	12270.73	6.75	0.0288	
AC		16990.60	2	8495.30	4.67	0.0405	
BC		99828.17	2	49914.08	27.46	0.0001	
A^2		1746.03	1	1746.03	0.9607	0.3526	
B^2		13273.12	1	13273.12	7.30	0.0243	
ABC		6136.70	2	3068.35	1.69	0.2385	
A^2C		1031.88	2	515.94	0.2839	0.7594	
B^2C		9969.09	2	4984.55	2.74	0.1175	
Residual		16357.15	9	1817.46			
Cor Total		5.661E+06	26				
Std. Dev.	42.63	R^2	0.9971				
Mean	1858.94	Adjusted R^2	0.9917				
C.V. %	2.29	Predicted R^2	0.9690				
		Adeq Precision	37.6191				

Table 3.8: Number of Optimization Solutions

Number	Irrigation deficit%	NPK Application rateKG/HA	Tillage	Crop Yield	Desirability	
1	11.594	596.406	2	2543.589	1.000	Selected
2	10.154	599.069	2	2548.833	1.000	
3	12.194	599.053	2	2543.018	1.000	
4	11.048	597.860	2	2545.808	1.000	
5	10.428	595.845	2	2546.531	1.000	

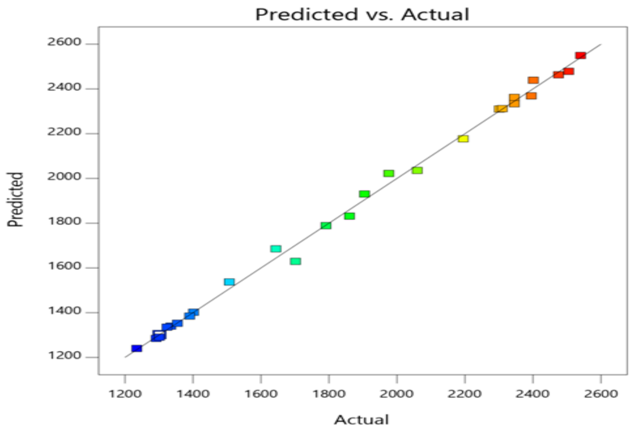

Fig 3.1: Diagnostics Plots of the fitted Quadratic Model for Crop yield

tillage (0.08 cm3/cm3). According to the data, field capacity increased as soil depth increased, which is consistent with Alam and Salahin (2013) finding that it increased from 0.24 cm3/cm3 to 0.3 cm3/cm3.

Permanent Wilting Point (PWP)

According to the findings, permanent wilting point (PWP) increased with soil depth in both conventional tillage and no tillage, with PWP values of 0.01cm3/cm3, 0.05cm3/cm3, 0.09cm3/cm3, and 0.11cm3/cm3 at soil depths of 0–25 cm, 25–50 cm, 50–75 cm and 75–100 cm, respectively, for conventional tillage and 0.02cm3/c.

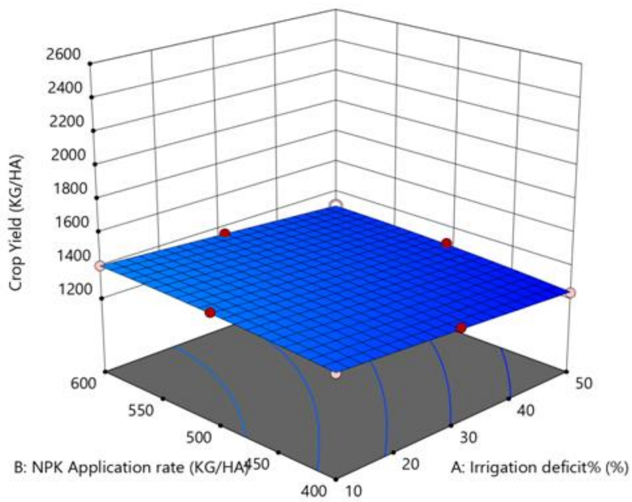

Fig. 3.2: Statistical 3D plots for Crop yield (No Tillage)

This is consistent with the findings of Alam and Salahin (2013), who found that the permanent wilting point increased when soil depth increased from 0.10 cm3/cm3 to 0.15 cm3/cm3. For conservative tillage pwp of $0.05cm^3/cm^3$, $0.04cm^3/cm^3$, $0.09cm^3/cm^3$, and $0.07cm^3/cm^3$

were recorded for 0-25cm, 25-50cm, 50-75cm and 75-100cm soil depths respectively. The permanent wilting point for conservative tillage varied, this could be as a result of the soil bulk density.

Grain Cob^{-1}

This is the number of grains on a corn cob, and Table 3.1 shows the numbers for various treatments.

The maximum grain cob-, 594, was obtained in conservative tillage at 10% MAD and 600 kg/ha NPK, while the lowest was produced with no tillage, 50% MAD, and 400 kg/ha NPK application, according to the results of the grain cob- in Table 3.1. For conventional tillage, conservative tillage, and no tillage, the average grain per cob yielded was 454.5, 515.1, and 416.7, respectively. According to Anjum *et al.* (2019), the lowest number of grain cobs—319—was achieved on no tillage, while the highest number—528, was acquired with conventional tillage. The soil type, infiltration rate, and permeability may have an impact on the results.

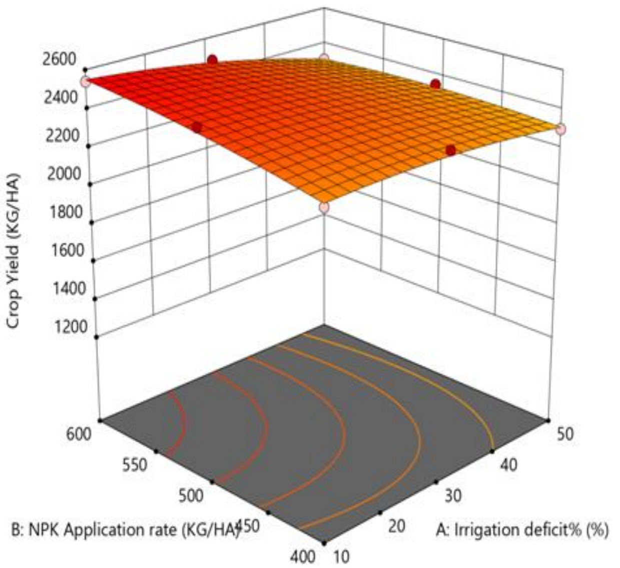

Fig. 3.3: Statistical 3D plots for Crop Yield (Conservative Tillage)

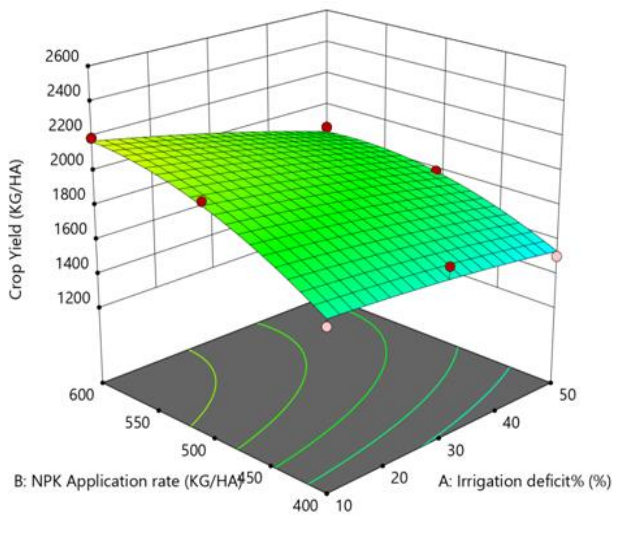

Fig. 3.4: Statistical 3D Plots for Crop Yield (Conventional Tillage)

1000- Grain Weight

Table 3.2's 1000 grain weight results show a similar tendency to that seen in grain cobs, with the maximum 1000 grain weight reported in conservative tillage (10%MAD/600Kg/Ha) and the lowest in no tillage (50%MAD/400Kg/Ha). The average 1000 grain weights for conventional tillage, conservative tillage, and no tillage were 291.5g, 295.5g, and 158g, respectively. Anjum *et al.* (2019), who obtained the highest 1000 grain weights of 265g with conventional tillage and the lowest value of 204g at no tillage, disagree with this as well. This discrepancy in results may be due to the various soil types in the study regions.

Cob Weight

The figures for each corn cob's weight in grams for all treatments are listed in Table 3.3.

The average cob weight for conventional tillage, conservative tillage, and no tillage, respectively, was 392, 399, and 283.3 grams, with the highest cob weight of 406 grams attained under conventional and conservative tillage/10%MAD, 600Kg/Ha NPK. The lowest cob weight, 347g, was likewise attained in a 600Kg/Ha NPK, 50%MAD, no tillage situation. This is consistent with Leghari *et al.* (2017), who found that conventional tillage yielded the highest cob weight of 455g, followed by reduced tillage with a cob weight of 408, and no tillage with a cob weight of 234g.

Grain Yield

The crop yield for the various treatments is shown in Table 3.4.

The average grain yields for conventional tillage, conservative tillage, and no tillage were 1848.8, 2135.8, and 1325.9 kg/ha, respectively. Table 3.4 demonstrates that the highest crop yield, 2540 kg/ha, was obtained in conservative tillage/10%MAD/600 kg/ha NPK, while the lowest crop yield, 1234.67 kg/ha, was obtained in no tillage/50%MAD/400 kg/ha NPK. This result is consistent with Grigoras *et al*. (2011), analysis of maize production under conventional and conservative tillage, which found that conservative tillage produced the highest crop yield of 6221.08Kh/Ha and the lowest crop yield of 5372.0. In contrast, Asenso *et al.* (2018) found that subsoiling produced the best crop production (7.34 tons per hectare) while zero tillage produced the lowest crop output (6.70 tons per hectare).

Regression Model Development

To maximize characteristics, Central Composite Design (CCD) was applied. Table 3.5 displays the statistical combination of the independent factors and the experimental result. The significance of the coefficient was assessed based on the p-values in order to create a regression model that was statistically significant. Because p = 0.005 was utilized, coefficient terms with p-values greater than 0.05 are not significant. 3.5 Design Summary Table.

The experiment's design was based on the values listed in Table 3.5. The answer is crop yield (Kg/Ha), and the factors are irrigation deficit percent, NPK application rate (Kg/Ha) and tillage. A numerical component with a range of 10% to 50%, irrigation deficit has a mean of 30% and a standard deviation of 16.64. T he NPK Application Rate, another

Factor	**Name**	**Units**	**Type**	**Min**	**Max**	**Coded Low**	**Coded High**	**ean**	**Std Dev.**	
A	Irrigation	%	Numeric	10.00	50.00	-1 ↔ 10.00	+1 ↔ 50.00	30.00	16.64	Deficit
B	NPK App.	KG/HA	Numeric	400.0	600.0	-1 ↔ 400.00	+1 ↔ 600.00	500.00	83.21	

C Tillage Categoric 1 3 **Levels:3**

Response	Name	Units	Observations	Analysis	Min	Max	Mean	Std. Dev.	Ratio	Transform	Model
R1	Crop Yield	KG/HA	27	Polynomial	1234.67	2540.09	1858.94	466.62	2.06	None	Reduced Cubic

numerical element, has a mean of 500Kg/Ha and a standard deviation of 83.21. Its minimum and maximum values are 400Kg/Ha and 600Kg/Ha, respectively.

There are three levels of tillage: no tillage, conservative tillage, and conventional tillage. Crop yield, the answer, ranges from a high of 2540.09 to a low of 1234.67, with a mean of 1858.94 and a standard deviation of 466.62 between them.

Crop Yield Statistical Analysis

Due to its highest order polynomial, the sequential model with two factor interactions (linear, 2FI, quadratic, and cubic polynomials) on Table 3.6 was chosen by Design Expert 11.1.2.0 version.

The significance of the fitness of the chosen quadratic model, as well as the relevance of individual terms and their interaction on the selected responses, were assessed using the analysis of variance (ANOVA). According to Table 3.7, the model's F-value of 182.70 and P-value of 0.0001 indicate that it is significant at the 95% level of confidence. The significance of each regression coefficient and the interaction impact of each cross product are evaluated using the P-value (probability of error value). When it comes to model terms, a p-value of less than 0.05 indicates that they are significant. In this situation, the model terms A, B, C, AB, AC, BC, and B2 are significant.

The fitted model has an R-square of 0.9971 and a 42.63 standard deviation. At a 95% confidence level, it was discovered that the three variables—Irrigation Deficit, NPK Application Rate, and Tillage—were statistically significant. A low coefficient of variation (0.073%) indicated that the values were highly precise and reliable. With an R2 value of 0.9917, the predicted values vs the actual values for crop yield reveal a model with 99.17% variability, as illustrated in Figure 3.1. The Predicted R-Squared of 0.9690 and the Adjusted R-Squared of 0.9917 are reasonably in agreement, with the difference between them being less than 0.2 and their R2 values being close to one. This suggests that the data and the model are compatible.

The investigation of residuals, which is the discrepancy between the observed reaction and expected response, was done to confirm the suitability of the model used. The actual value and the values predicted by the model have a strong correlation, as shown by the plot of actual vs predicted in Figure 3.1, and the model does not exhibit any variation in the constant variance.

Model Equation for Crop Yield

Model equation for crop yield (No Tillage) = 905.86125 - 2.39650A + 1.70182B – 0.000020 A * B - 0.001463A² - 0.001391B² 3.1

$$905.86125 - 2.39650A + 1.70182B - 0.000020\,A*B - 0.001463A^2 - 0.001391B^2 \quad (3.1)$$

Model equation for crop yield (Conservative Tillage) =

$$1320.33514 + 12.90729A + 3.44454B - 0.023251A*B - 0.081683A^2 - 0.002274B^2 \quad (3.2)$$

Model equation for crop yield (Conventional Tillage) =

$$1889.28653 + 8.86883A + 13.15142B - 0.024695A*B - 0.044796A^2 - 0.010445B^2 \quad (3.3)$$

Eliminating the non significant terms give:

Model equation for crop yield (No Tillage) =

$$905.86125 - 2.39650A + 1.70182B - 0.000020\,A*B + 0.001391B^2 \quad (3.4)$$

Model equation for crop yield (Conservative Tillage) =

$$1320.33514 + 12.90729A + 3.44454B - 0.023251A*B + 0.002274B^2 \quad (3.5)$$

Model equation for crop yield (Conventional Tillage) =

$$1889.28653 + 8.86883A + 13.15142B - 0.024695A*B + 0.010445B^2 \quad (3.6)$$

The equations can be used to make predictions about the response for given levels of each factor. Predictions regarding the reaction for specific amounts of each factor can be made using the formulae.

Statistical 3D plots for Crop Yield

According to the 3D plots of crop yield shown in Fig. 3.2–3.4, crop yield decreases with increasing irrigation deficit and NPK application. This is because high crop yields only occur when there is an adequate supply of water, or when soil moisture is not diminished beyond a reasonable moisture range.

Based on the resulting model and the inputted experimental data, Design Expert 11.0 software created the answers of the variables in Table 3.8 for optimization. The run 1 order from Table 3.8 provided the best condition, hence it was chosen. Based on the run order 1 figures, the irrigation deficit was 11.594%, the NPK application rate was 596.406 kg/ha, conservative tillage was the optimal tillage technique, and crop yield was 2543.589KG/HA.

Conclusion

The study at the Department of Agricultural and Bioresources Engineering Experimental Farm, Nnamdi Azikiwe University, Awka, demonstrated that drip irrigation might result in good crop output.

According to the experiment's results, conservative tillage produced higher crop yields than conventional and no-till farming methods. This is because conservative tillage disturbs the soil just minimally, maintaining the soil's quality. In all tillage techniques, increasing NPK application and reducing irrigation deficit boosted crop output.

The optimal levels of the process components were determined using the Central Composite Design (CCD) optimization model. The model indicates that the optimal response value achieved is Crop yield of 2543.589Kg/Ha for Irrigation Deficit of 11.594%, at NPK Application Rate of 596.406KG/HA, with Conservative Tillage.

REFERENCES

African Economic Commission (ACPC) (2011). Analysis of Knowledge Gaps and Needs in Relation to Climate Change and Agriculture. Working Paper 7 of the United Nations Economic Commission for Africa.

Aghamelu BI, BCE Egboka and BI Odoh, 2012. The soil conditions of Nnamdi Azikiwe University's permanent location in Awka, South Eastern Nigeria. Canadian Journal of Pure and Applied Sciences 6(1):1837–1845

Alam MK and Salahin N, 2013. the effects of various tillage depths and cropping patterns on changes in the physical characteristics of the soil and crop productivity. Agril. Res in Bangladesh 38(2): 289-299

Alam K, M Hasanuzzaman, M Monirul and N Salahin, 2014. Under subtropical climatic circumstances, the impact of tillage practices on soil characteristics and crop yield in the wheat-mungbean-rice cropping system. Journal of the Scientific World.

Anjum SA, Raza MM, Ullah S and Yousaf MM 2019. Impact of various tillage techniques on the harvest of autumn-planted maize (Zea mays L.). 32(2): 293–301 Pakistan Journal of Agricultural Research.

Anyadike RNC, 2009. Nigeria's experience with climate change and sustainable development: Conceptual and empirical challenges. African Institute for Applied Economics' Enugu Forum Policy Paper 10

Asenso E, Jiuhao L, Lian H, Fuseini I, Kai T, Lina Z, Luyong Z and Haibo C 2018. Tillage effects on soil biochemical properties and maize grown in latosolic red soil of Southern China. Applied and Environmental Soil Science https://doi.org/10.1155/2018/8426736

Eboh E, 2009. African Institute for Applied Economics in Enugu, Nigeria, discussing a policy alternative for the growth of the country.

Grigoras MA; Popescu A; Pamfil D, Has I and Cota LC 2011. Effect of conservation agriculture on maize yield in the Transilvanianplain, Romania. International Journal of Agricultural and Biosystems Engineering 5(6): 339-344.

IPCC 2007. Impact, adaptation and vulnerability-contribution of work group of the intergovernmental panel on climate change to the third assessment report of IPCC London. Cambridge university press.

Kang Y, S Khan and X Ma, 2009. Crop output, crop water productivity, and food security are all impacted by climate change. a summary. Natural Science Progress 19: 1665–1674.

Leghari N, Shah AR, Farhad W and Hammad HM 2017. Influence of tillage practices on yield components and economicanalysis of maize. Pak. J. Agril. Engg., Vet. Sci. 33(1): 66-73.

Mendelson R, Dinar A and Dalfelt A, 2008. African agriculture is impacted by climate change, Climate and Water, edited by Brates B, ZW Kundewicz, S Wu and Palutik of.

Ozor N, 2009. Understanding Climate Change: Implications for Nigerian Agriculture, Policy and Education. A paper was presented at the national conference on climate change and the Nigerian environment, which was held in Nsukka, Nigeria, 29 June–2 July, and was organized by the geography department of the University of Nigeria.