EVALUATION OF FIVE MAIZE VARIETIES UNDER OPTIMAL AND SUBOPTIMAL CONDITIONS

Ebireri M.U[1]., Enudeme, N.M[2].,Elumalero, G. O.[3], Akinbile, O.O. [4], and Williams-Nnani. M.C[5].

Department of Agronomy, Poznan University of Life Science.
Department of Agronomy, College of Agriculture, Iguoriakhi.
Forestry Research Institute of Nigeria, Jericho, Ibadan, Oyo State, Nigeria.
Department of Soil Science, University of Ibadan.
Department of Plant Breeding, University of Ibadan.

ABSTRACT

The maize (Zea mays) crop brings profound returns on investment, and its farming gives high potential profit for Nigeria and its populace. Seed and crop production technologies include the use of extra early varieties, timely planting and weeding, fertiliser and herbicides, modern tillage equipment, and harvesting. Five maize varieties were evaluated under optimal and suboptimal conditions in Ibadan, Nigeria, for 3 months. The goal of this study is to identify the highest-yielding maize variety among those being evaluated, as well as the best genotype under optimal and suboptimal growth conditions. Each block consisted of five (5) treatments. Plant height, number of leaves, leaf length, leaf width, leaf area, stem girth, days to 50% tasselling, weight of cob with husk, weight 3 months., weight of 100 grains, grain yield, cob diameter, and stover weight are among the growth parameters assessed. PVA SYN-13-13 performs better in the SYN-13.

16 growth and yield parameters under optimal and suboptimal conditions than the check (Agbado). Under optimal conditions, DTSR YSYN-2 performed better than PVA SYN-3 under suboptimal conditions. The optimal block performs better in all growth and yield parameters when compared to the suboptimal maize block. This result demonstrates that soil and environmental factors such as fertiliser application, weeding, herbicide application, irrigation, and other factors must be considered to ensure higher plant yields. Therefore, PVA SYN-13 under optimum and suboptimal conditions could be confirmed as a high-yielding extra-early maize variety.

Keywords: Food and livelihood security, sustainable agriculture, crop production, and agronomic management.

INTRODUCTION

Maize (Zea mays L.) is one of the most widely consumed staple foods in Africa and around the world. It belongs to the Gramineae grass family, with its origin in South and Central America (Olaniyi, 2012; Gibson and Benson, 2002). Maize plays a central role as a staple food in Africa and Central America (CGIAR, 2016), with production globally across temperate and tropical zones spanning all continents.

The daily consumption of maize and its processed products necessitates innovation and improved manufacturing methods. These production processes must be optimised for efficiency, which translates into higher yield, as opposed to conventional agronomic production processes, which may be suboptimal. The growth and productivity are hampered by the inefficient use of fertiliser, herbicides, pesticides, and management potentials; these conditions are referred to as suboptimal, whereas the optimal production conditions are those in which all inputs are utilised. In developing countries, maize production systems have improved greatly in different ways, but some issues about soil erosion, soil fertility loss, land degradation, and weathering still affect them (OECD FAO 2014). Currently, farmers have few options for high-yielding early maize genotypes that fit into various cropping patterns (Kunwar *et al.,* 2014). Maize genotypes are constantly being improved, with high-yielding and early-maturing varieties that are highly adaptable to various environments in the current cropping system. In regions where food is scarce, this could increase and stabilise maize yield (Dhakal, 2017).

Additionally, the growing human population is driving up the demand for maize (Steensland, 2022). This geometric population rise has led to competition with the use of arable land due to other human activities such as construction and real estate, which are equally important for human survival. Therefore, there is a need to optimise maize production techniques. Hence, it is necessary to evaluate some maize varieties cultivated in optimal conditions and suboptimal conditions for growth and yield.

This study evaluates the growth and yield of five maize varieties at optimal and suboptimal conditions.

MATERIALS AND METHODS Study area

The study was carried out at old Ife Road, Ibadan, Oyo State, with the following coordinates: 07.39^{0} N, 003.92 E. Loamy sand made up the trial soil, and planting took place from August to November 2019—a time when the nation experienced late-season rainfall (NiMet, 2019).

Soil sampling and baseline physicochemical analysis

Using a soil auger, samples of 0 to 15 cm of the topsoil were taken. The samples were then allowed to air dry, gently crushed, and sieved through a 2 mm sieve. The following analyses were carried out for each soil sample using standard methods: Soil particle size (Gee and Or, 2002), soil pH (Thomas, 1996), organic matter (Nelson and Sommers, 1996), total nitrogen (Bremmer, 1996), available phosphorus (Kuo, 1996), exchangeable cation (Summer and Miller, 1996), and heavy metals.

Seed selection and experimental design

The seeds for the experiment were selected from the seed shop located at Bodija Market, Ibadan, with random varieties, which are DTSR-YSYN 2, PVA SYN-3, 65 PVA SYN-6, and PVA SYN-13, and a variety used by local farmers named “Agbado” was used as the control for the study. "Optimal" and "sub-optimal" conditions were two new elements added to the experimental design. The experimental design was a 2 x 5 factorial experiment in a randomised complete block design (RCBD) replicated three times.

Table 1: Agronomic conditions for optimal and suboptimal conditions

Agronomic practices	**Optimal condition**	**Sub-Optimal condition**
Weeding	Weeding is done 4, 6, and 8WAP (weeks after planting)	Weeding done at 4WAP
Fertiliser	Fertiliser	No fertiliser Application
Insecticide: this is applied to kill insects. Pest.	Sprayed with insecticide (caterpillar force at 2L/Hectare)	Sprayed minimally with insecticide (caterpillar force at 1L/Hectare)

Agronomic data collected

1. Plant height: Weekly measurements of plant height were taken between 3 and 8 WAP. For ten sampled plants, it was taken from ground level to the tip of the uppermost leaf blade.

2. Stem girth (cm): Stem girth was also measured every 2 weeks (i.e., from 2, 4, 6, and 8 WAP) at 5 cm (from the ground level) of 10 sampled plants. Stem diameters of the randomly selected six plants were taken using a pair of vernier callipers. The measurement was taken 10 cm from the ground level and converted to girth with the following formula:

Stem girth (SG) = stem diameter (D) x π

(pi) Where π = 22/7 (constant) (Ukonze,

2016).

3. Number of leaves/plants: The number of leaves per plant was taken every other week (3 WAP to 8 WAP for 10 sampled plants), and the leaf after the coleoptile was regarded as leaf 1.

4. Leaf length: The length of the 2 leaves was taken with a ruler.

5. Leaf width: The width of two leaves was taken with a ruler.

6. Leaf area: The leaf area index was calculated using:

Leaf area = leaf length x leaf breadth x 0.75 (constant).

(L x W) where Leaf Area Where: k =

0.75, which is constant for all cereals

L = leaf length,

W = leaf width

With a centimetre of tape, the leaf area was measured. This was achieved by measuring the widest part of each leaf per plant and the leaf length and multiplying by 0.75 (Aikins *et al.,* 2012).

7. 50 percent tasselling: The maize of ten sampled cobs was counted from the day planted to the day it was tasselled and analysed.

8. Fresh cob weight (g): The fresh weights of the maize cob were taken for 10 sampled cobs/plots after harvest.

9. Dry weight of cob with husk (g): The dry weights of the maize cob were taken for 10 sampled cobs/plots after they were air-dried.

10. Dry weight of cob (g): The dry weights of maize cob for 10 sampled cobs/plots were taken after they were air-dried.

11. Weight of dry grain (g): The dry weights of the grain of maize for 10 sampled cobs or plots were taken after they were air-dried.

12. Diameter of maize cob (g): Ear diameter was measured at the middle of the cob with a vernier calliper for 10 sampled cobs.
13. Length of maize cob (cm): The length of maize cob was measured from the base of the cob to the tip of the cob with a ruler for 10 sampled cobs.
14. Weight of hundred (100) seeds (g): Weight of hundred (100) seeds was measured by weighing the cob for 10 sampled cobs.
15. Weight of maize Stover after drying: The dry weights of the grain of maize for 10 sampled plants/plots were taken after they were air-dried.
16. Dry grain yield (t/ha) and shelling percentage (%

Wase cobs were harvested from each net plot with an area of 5.62 m2. of the blocks were threshed and cleaned. Ears were air-dried, and the dry ear weight was recorded. The maize was later shelled and grain weights were recorded. Shelling percentage and grain yield were calculated using the formulas below:

Grain yield = mean grain weight/cob (kg) x number of plants/ha (Ciampitti and Vyn, 2011).

Shelling percentage (%) = grain dry weight/ear dry weight x 100 (Bakht *et al.,* 2006).

Data Analysis

The collected data were subjected to variance analysis using R statistical software, version 4.0.5 (R Core Team 2021). Means were separated using Least Significant Difference LSD at p < 5%.

RESULTS AND DISCUSSION

Table 2 shows analytical data from the experimental soil before planting, indicating that the soil is adequate in nitrogen, calcium, magnesium, potassium, and phosphorus. Maize, a global staple crop, requires good environmental conditions for production (Caimset al., 2021), and this baseline analysis of the soil sample collected indicates that the soil is adequately nourished to support maize production

Table 2: Baseline soil analysis for the study area evaluating optimal and sub-optimal conditions for maize production in Ibadan, Nigeria.

Soil Properties	Values	Critical value	Remark (Chude *et al.,* 2012)

Soil pH (1:1, H2O)	7.04	6.6 – 7.2	Slightly alkaline
Organic Carbon (%)	1.72		
Available Phosphorus (P)(mg/kg)	14	7 – 20	Moderate
Total Nitrogen (N) (g/kg)	1.5	1.5 – 2.0	Adequate
Exchangeable cations (cmol/kg)			
Calcium (Ca)	2.6	0.5 - 5	Adequate
Magnesium (Mg)	1.1		
Potassium (k)	0.7	0.3 – 0.6	Adequate
Sodium (Na)	0.2		
Extract. micronutrients (mg/kg)			
Manganese (Mn)	0.7	0.5 – 6	Low
Iron (Fe)	14	2 – 10	High
Copper (Cu)	0.7	0.1 – 3	Low
Zinc (Zn)	1.3	0.5 - 5	Moderate
Particle size distribution (%)			
Sand	84.4		
Silt	7.4		
Clay	8.2		
Textural class (USDA)	Loamy sand		

The mean plant height of the 5 maize varieties under optimal and suboptimal conditions is shown in Figure 1. Maize varieties grow taller over time in both optimal and suboptimal blocks. The slope of the curve shows that the optimal block's growth clusters outperformed the suboptimal block across all weeks. Eight weeks after planting in the optimal and suboptimal blocks, respectively, DTSTR-YSYN 2 and PVA SYN 3 showed the best performance in terms of growth and yield in terms of mean plant height, making them the best genotypes under ideal conditions.

On the other hand, when we contrast the varieties' suboptimal performance with their optimal performance, we find that plant height significantly changed. Thus, it can be concluded that favourable conditions are essential for crop growth. This is consistent with the results reported by Sharafati et al. (2022), who also highlighted the importance of favourable environmental conditions for crop performance. Extra-early varieties often have a relatively consistent effect under both optimal and suboptimal conditions. The relationship therefore was not significant among varieties but significant among blocks.

Figure 1. The plant height (cm) of 5 maize varieties and their responses under optimal and suboptimal blocks weeks after planting

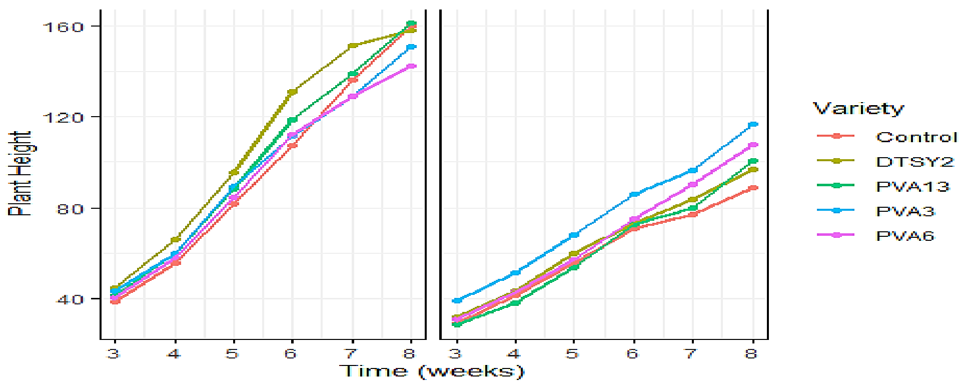
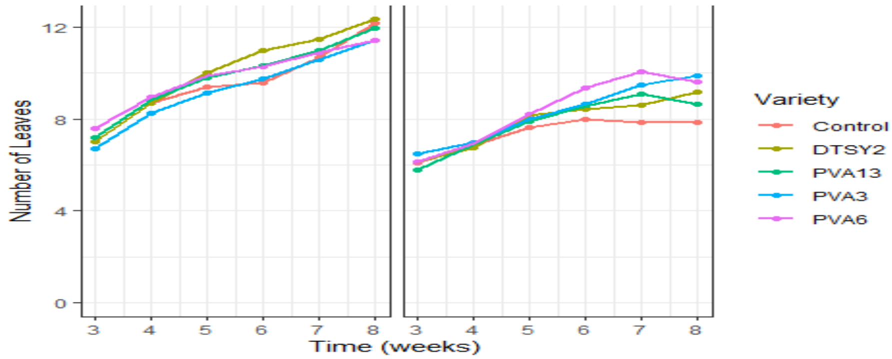


Figure 2 shows the final mean number of leaves for the five maize varieties of maize at 8 weeks after planting. The number of leaves for each of the five maize varieties increases over time in both optimal and suboptimal blocks. The slope of the curve shows that the optimal block's growth clusters outperformed the suboptimal block across all weeks. The varieties that had the mean highest performance at 8 weeks after planting were DTSTRYSYN 2 and PVA SYN 6 planting across the weeks for both optimal and suboptimal blocks. In the optimal plot, the performance of the varieties was superior to that of the same varieties in the suboptimal plot. According to the slope, there was no significant difference in performance between the varieties in both optimal and suboptimal blocks. These findings are in agreement with Munyasya et al. (Just et al., 2022), who reported the importance of maize leaves in cob formation and energy reservoirs, and these functions are best performed under optimal environmental conditions, which supports better production.

Figure 2: The mean number of leaves (cm) of 5 maize varieties and their responses under optimal and suboptimal blocks weeks after planting



The mean leaf length of the genotype under optimal and suboptimal conditions of growth and yield of maize is shown in Figure 3. The duration of different maize varieties increases over several weeks in both optimal and suboptimal blocks. The slope of the curve shows that the optimal block's growth clusters outperformed the suboptimal block in all weeks. PVA 3 was performing better under both optimal and suboptimal agronomic conditions every week, as indicated by the slope of the curve in the optimal and suboptimal blocks. Comparing the optimal plot to the suboptimal plot, the former yields the maximum leaf length. This demonstrates that the use of agronomic techniques in crop production can result in improved crop growth performance, a finding that is further supported by Shah and Wu's reports (2019). The slope revealed no significant difference in the performance of the varieties under optimal and suboptimal conditions.

Figure 3: The mean leaf length (cm) of 5 maize varieties and their performance under optimal and suboptimal blocks weeks after planting

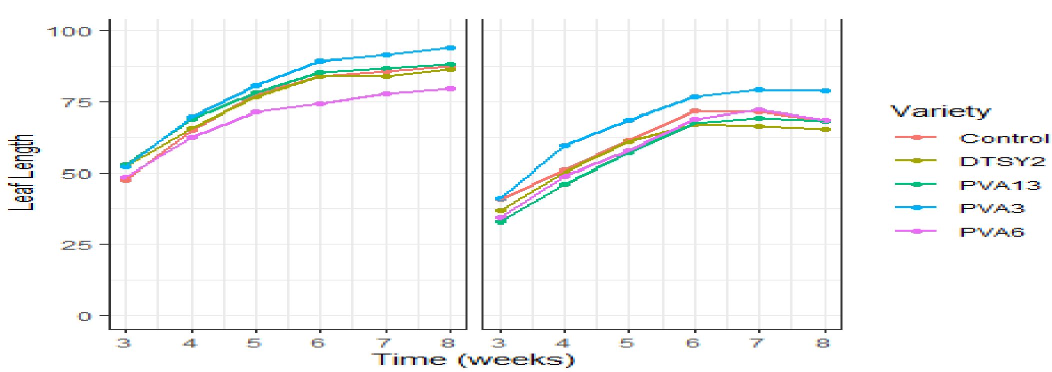
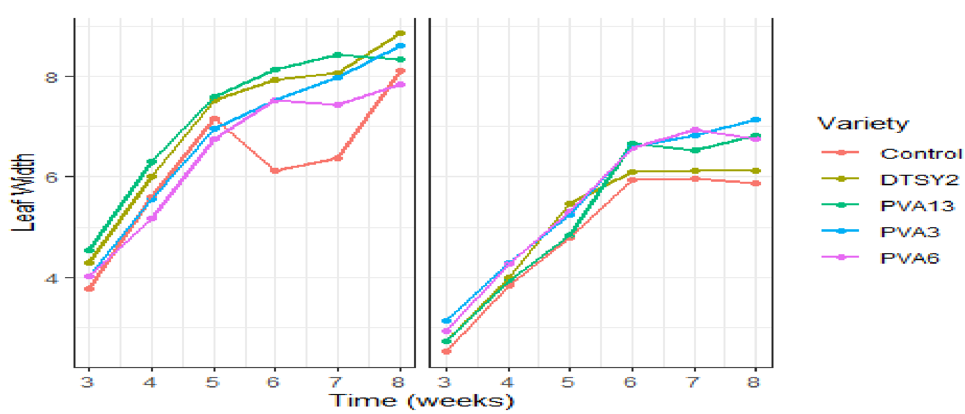


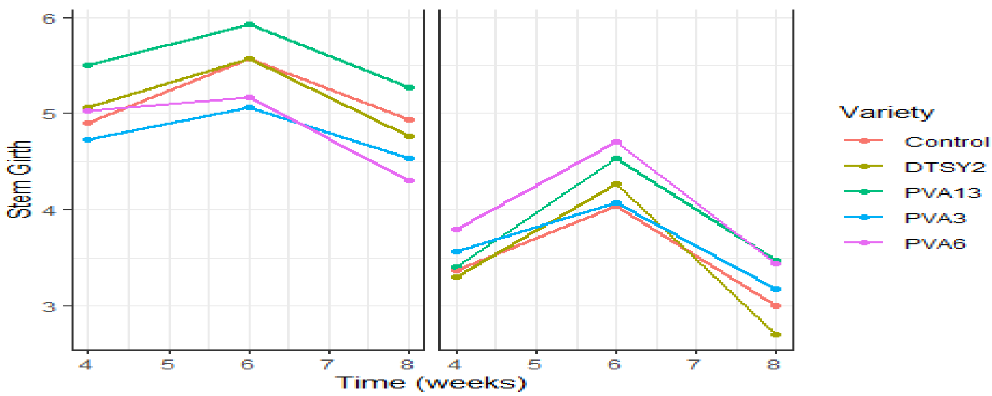
Figure 4 shows the mean leaf width for the five maize varieties of maize at 8 weeks after planting. The mean leaf width of the five maize varieties increases over the weeks in both optimal and suboptimal blocks. The slope of the curve shows that the optimal block's growth clusters outperformed the suboptimal block in all weeks. The variety that gave the best performance under optimal and suboptimal conditions of crop growth and yield was DTSTR YSYN 2. The optimal and suboptimal block performances were highest for PVA SYN 13 and PVA SYN 3, respectively. The suboptimal block performing better than the suboptimal block is largely due to the agricultural practices that were taken into consideration in this study. Based on the slope, there was no significant difference in the performance of the varieties at both optimal and suboptimal plots. But when we compare the varieties' optimal performance to their suboptimal performance. , leaf width responded significantly. This is consistent with the findings of Huang et al. (2023) and Fan et al. (2022), who noted the significance of leaf width as an important growth indicator for improved maize growth and yield performance.

Figure 4: The mean leaf width (cm) of five maize varieties and their performance under optimal and suboptimal conditions after planting



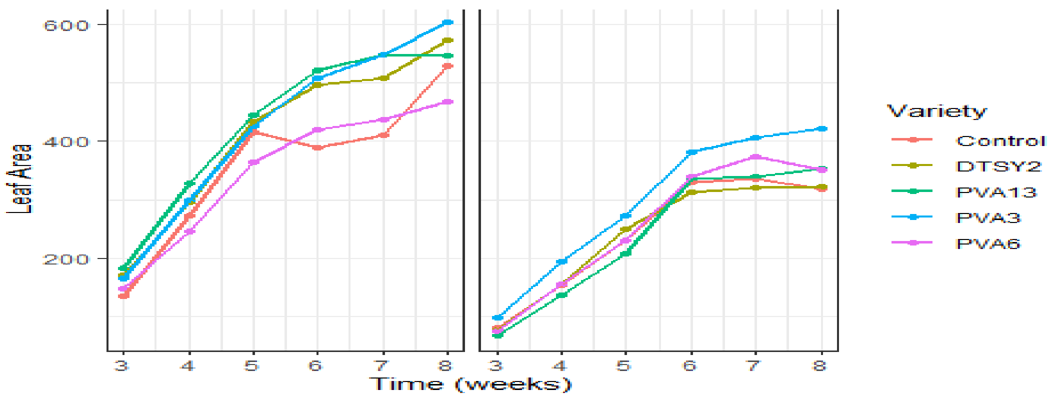
The mean stem optimal conditions under optimal and suboptimal conditions are shown in Figure 5. The mean stem girth of the five maize varieties increases across the weeks for both optimal and suboptimal blocks, respectively. As the curve slope suggests, the growth clusters in the optimal block performed better than those in the suboptimal block for every week. The slope of the curve shows that under optimal conditions of growth and yield, the genotype PVA13 performed better across all 8 weeks of growth, while under suboptimal conditions, PVA 6 gave the best performance. PVA13 and PVA6, which performed at the highest levels throughout all weeks, were the best genotypes under ideal growth and yield conditions among the extra-early genotypes in terms of mean stem girth. Based on the slope, there was no significant difference in the performance of the varieties at both optimal and suboptimal blocks. However, there was a highly significant difference among plots. This supports the findings of Riadi et al. (2021) and Kareem et al. (2017), who noted the significance of good stem girth as an indicator of good crop yield and performance, and suggests the significance of stem girth for food storage that promotes growth and improves crop yield.

Figure 5: The mean stem girth (cm) of maize varieties and their performance under optimal and suboptimal blocks weeks after planting



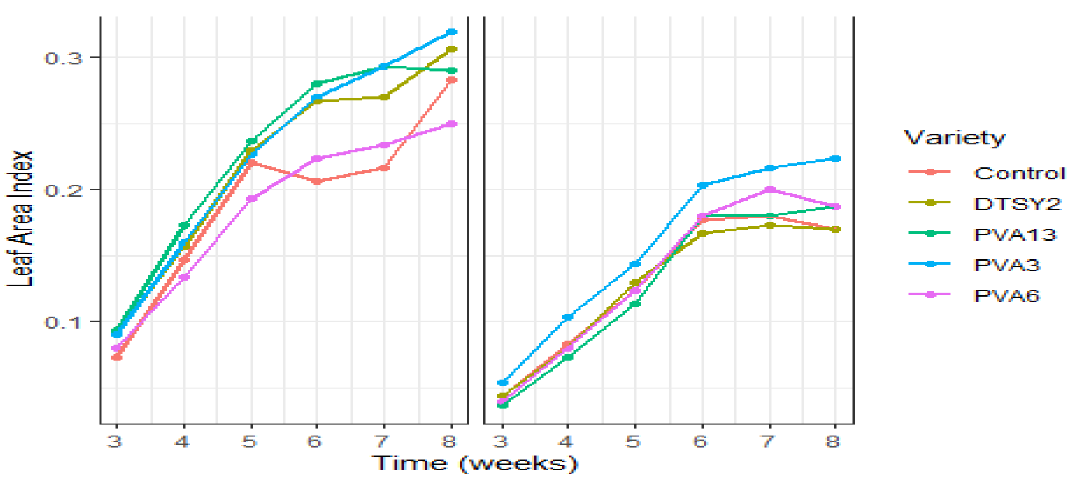
The mean leaf area of the genotype under optimal and suboptimal conditions is shown in Figure (6). The mean leaf area of the five maize varieties increases across the weeks for both optimal and suboptimal blocks, respectively. The slope of the curve shows the growth clusters of the optimal block performing better across all weeks than the suboptimal block. The slope of the curve shows that under optimal conditions of growth and yield, the genotypes PVA SYN 13 and PVA SYN 3 gave the best performance under suboptimal conditions. Thus, among the extra-early genotypes, PVA SYN 3 is the best genotype under ideal growth and yield conditions based on mean leaf area, according to the conducted studies. This therefore tells us that favourable agronomic conditions influence crop growth and yield. Based on the slope, there was no significant difference in the performance of the varieties at both optimal and suboptimal conditions. According to Raza et al. (2022), leaf area is crucial to crop growth and yield. This study supports their findings, as ideal environmental conditions promote improved leaf area growth performance and support maize growth and yield overall for the security of food and livelihood.

Figure 6: The mean leaf area (cm) of five maize varieties and their performance under optimal and suboptimal blocks weeks after planting



The mean leaf area index of the genotype under optimal and suboptimal conditions is shown in Figure 7. For both optimal and suboptimal blocks, the mean leaf area index of the five types of maize increases week by week. The growth clusters of the optimal block outperformed the suboptimal block overall weeks, as indicated by the slope of the curve. The slope of the curve shows that under optimal conditions of growth and yield, the genotype PVA SYN 13 performed better, while PVA SYN 3 under suboptimal conditions gave the best performance. The studies carried out therefore show the best genotype under optimal and suboptimal conditions of growth and yield among the genotypes cultivated in terms of mean leaf area index is PVA SYN 3. This result also shows favourable environmental conditions to be very essential for plant growth. The performance of the varieties under both optimal and sub-optimal conditions did not differ significantly, according to the slope. However, there was a significant difference among blocks.

Figure 7: The mean leaf area index (cm) of five maize varieties and their performance under optimal and suboptimal blocks weeks after planting



The yield data shown in Table 3 shows that under optimal and suboptimal conditions of growth and yield, the mean number of days to 50% maize tasselling varied little between varieties but significantly between blocks. DTSY2 and PVA6 are said to reach 50% tasselling earlier by 56.33 and 56.83 days, respectively. The optimal plot also reaches 50% tasselling than the suboptimal block 54 days after planting (Table 3). This demonstrates that conducive environments are necessary for crop growth. Furthermore, since days to 50%, tasselling is a significant yield parameter that affects crop yield, it validates the findings of Ali et al. (2013), who reported the significance of favourable environmental conditions for maize performance. The yield data shows that under optimal and suboptimal conditions of growth and yield, the mean number of fresh weights of a cob of five maize varieties cultivated was not significant among varieties but highly significant among blocks. PVA Syn. 13 gave the highest fresh weight at 52.96 g.

In Table 3, the optimal plot yields the highest fresh weight value of 59.82 g, while the suboptimal plot yields the lowest value of 39.67 g. This therefore, demonstrates that favourable conditions have a positive impact on the fresh weight of maize cob and is consistent with research findings from Chinthiya et al. (2019) and Aikin et al. (2012) regarding the significance of favourable environmental conditions supporting the weight of fresh maize cob. The responses of five maize varieties under optimal and suboptimal conditions in terms of the mean dry weight of maize cob with husk are in Table 3. There was no significant difference among varieties; a significant difference was observed among both blocks.

The variety with the highest mean value of maize cob with husk under both favourable and unfavourable growth and yield conditions was DTSR YSYN 2, weighing 78 g. The mean value of the optimal plot of 75.25 g was highly significant when compared to the suboptimal plot, which has a value of 40.73 g (Table 3). This demonstrates that favourable conditions are necessary for crop yield and for the formation of dry weights of maize cob, which have significant effects on sub-Saharan Africa's food security because they are a crucial part of animal feed.

The mean dry weight of the cob only is shown in Table 3. The results indicate that DTSR YSYN 2 outperformed the other varieties with a mean response of 38.9 g under both optimal and suboptimal growth and yield conditions. The maximum values of 45.64 are also produced by the optimal plot, whereas 21.94 g is produced by the suboptimal block (Table 3). There was a significant difference in cob dry weight wheat varieties and also between the optimal and suboptimal blocks, respectively. This therefore shows that favourable conditions are essential for the yield of crops

According to the genotyping study conducted under both favourable and unfavourable conditions, PVA SYN 13 has the widest maize cob width, measuring 9.90 cm. The cob widths of the other extra-early genotypes, DTSY2, PVA3, and PVA6, were 9.85 cm, 9.78 cm, and 9.78 cm, respectively, whereas the control genotype had the smallest cob width, 9.38 cm. The optimal block also produces the highest values of 10.30 cm, while the suboptimal block was 8.65 cm, respectively (Table 3). While there was a significant difference between the optimal and suboptimal blocks, there was no significant difference in the diameter of maize cobs between varieties. This therefore shows that favourable conditions are essential for the yield of crops.

Table 3: Summary of mean grain yield parameter (g/plot) of maize plants at 21-56 days after planting (DAP) in the field at Baptist building, gate area of Ibadan in the month of August-November, 2019.

Treatments	Days To 50% Tasseling	FCW (kg)	DCW. of maize With Husk (g)	DCW only (g)	DM Cob (cm)
Control	57.50	50.63	54.75	29.27	9.38
DTSY2	56.33	51.00	62.78	38.91	9.85
PVA13	57.33	52.96	50.97	28.00	9.90
PVA3	57.00	44.19	60.52	34.33	9.78
PVA6	56.83	44.96	60.93	37.63	9.78
LSD 0.05	1.485	23.562	11.916	6.961	1.123
Optimal	53.67	59.82	75.25	45.64	10.83
S-Optimal	60.33	39.67	40.73	21.94	8.64
LSD 0.05	0.839	22.26	7.451	4.229	0.778

Wt: weight, Var: Varieties, ns: Not significant, * significant at P ≤ 0.05, FCW: Fresh cob weight, DCW: dry cob weight, DM: diameter of maize

Table 4 displays the average length of corn cob for each of the five varieties of corn under both favourable and unfavourable crop growth and yield conditions. The table shows that the best variety in terms of mean length of maize cob is PVA3, with the longest cob of about 8.50 cm. The optimal plot gave the highest value of 9.27 cm when compared to the suboptimal block, which gave the lowest value of 6.83 cm. While there was a significant difference between the optimal and suboptimal blocks, there was no statistically significant difference in the length of maize cobs between varieties. The mean dry weight of one hundred (1 suboptimal maize) is shown in Table 4. DTSR YSYN 2 has the highest 100-seed height of 12.77 g. The mean dry weight of 100 did not differ statistically between varieties, but there was a significant difference between the optimal and suboptimal plots, respectively. In comparison to the suboptimal plot, which yields the lowest value of 10.82 g, the optimal plot's mean value yields the highest weight of 100 seeds, 13.77 g (Table 4).

Table 4 displays the average weight of dry grains under ideal and suboptimal crop growth and yield circumstances. While there was no statistically significant variation across varieties, there was a statistically significant variation in grain weight between blocks. PVA SYN 6 has the best value of 275.68g under optimal and suboptimal conditions of crop growth and yield, while DTSR YSYN 2 and PVA SYN 3 also produced a high value of 273.0g and 251.0g, respectively. The cob lengths with the lowest weights are PVA SY 13 and Control, at 207.33g and 205.50g, respectively. The optimal plot also produced the highest values of 339.07 g, while the plot was 145.93 g, respectively (Table 4).

The shelling percentage of 5 maize varieties under optimal and suboptimal conditions of crop growth and yield is shown in Table 4. There was no significant difference among varieties. The shelling percentage of the optimal and suboptimal blocks differed statistically significantly from one another. PVA SYN 13 has the best value of 74% under optimal and suboptimal conditions of crop growth and yield. The sub-optimal block yielded values of 66%, while the optimal block produced the highest values of 74% (Table 4).

The grain conditions of maize varieties under optimal and suboptimal conditions of growth and yield are shown in Table 4. The maize grain yield varied significantly (statistically) between blocks but not significantly between varieties. PVA Syn 13 produced the highest grain yield at 10.01 tons. The optimal experimental block produced the best grain yield performance under both optimal and suboptimal crop growth and yield conditions, with values of 10.03 tonnes and 8.98 tonnes, respectively (Table 4).

Table 4's yield data indicates that the mean dry weight of maize stover was highly significant under both optimal and suboptimal growth and yield conditions. The control variety had the highest value, measuring 126.62, compared to the extra-early varieties. PVA6 has the lowest value of 58.16 g (Table 4). Under optimal and suboptimal conditions of crop growth and yield, the optimal experimental block gave the highest performance with the values of 117.10 g, while the suboptimal block was 61.03 g, respectively (Table 4).

As a result, this study has demonstrated the significance of ideal environmental conditions for maize yield and yield components, which in turn affect the overall performance of maize production. This is necessary because maize is widely consumed in both raw and processed forms and it has industrial advantages. These findings are corroborated by reports from Sithole et al. (2023) and Mirabet (2023), which emphasise the significance of maize as a game-changer for ensuring food and livelihood security

Table 4: Summary of mean grain yield parameter (g/plot) of maize plants at 21-56 days after planting (DAP) in the field at gate area, Ibadan in the month of August-November, 2019.

Treatments	Length of Cob (cm)	Wt of Dry Grain (g)	Wt of 100-Seeds (g)	Shelling percentage (%)	Grain Yield (t/ha)	Dry Wt of Maize Stover (g)
Control	7.40	205.50	11.37	70	9.48	126.62
DTSY2	8.28	273.00	12.77	70	9.48	76.17
PVA13	7.92	207.33	11.72	74	10.01	101.23
PVA3	8.50	251.00	12.50	73	9.87	83.13
PVA6	8.15	275.67	13.10	73	9.9	58.17
$LSD_{0.05}$	0.932	56.622	1.962	7.95	1.92	26.354
Optimal	9.27	339.07	13.75	74	10.03	117.10
S-Optimal	6.83	145.93	10.87	66	8.98	61.03
$LSD_{0.05}$	0.693	32.494	1.329	7.261	1.214	16.668

Wt: weight, Var: Varieties, ns: Not significant, ***highly significant at $P \leq 0.001$

CONCLUSIONS

This study evaluated five maize varieties under optimal and suboptimal conditions of crop growth and yield. Drawing from the reported result, the subsequent inference can be made: PVA SYN 13 variety is the best variety under optimal and suboptimal conditions of crop growth and yield. The optimum plot has DTSR YSYN 2 has the best variety, while the suboptimal plot has PVA SYN 3 can survive and thrive very well under unfavourable conditions. Only the five types of maize demonstrate that ideal growing and yielding environments are necessary.

This study also demonstrates that in addition to a plant's genetic makeup, various soil and environmental factors—such as the use of fertiliser, weed control, herbicides, irrigation, and other measures—must be taken into account to guarantee a higher plant yield. This conditions. How agronomic practices such as weeding and fertiliser are unfavourable in a timely and recommended manner to ensure a better and higher yield increase in maize production. These findings need to be verified in the field, and additional basic research is required to understand the relationship between genotype and environment as well as the impact of agronomic techniques on extra-early cultivars of maize production.

REFERENCES

Aikins, S.H.M., J.J. Afuakwa, and Owusu-Akuoko, O. (2012). Effect of four tillage practices on maize performance under rainfed conditions. *Agriculture and Biology Journal of North America* 31:25–30.

Aikins, S. H. M., Afuakwa, J. J., & Owusu-Akuoko, O. (2012). Effect of four different tillage practices on maize performance under rainfed conditions. Carbon, 1, 1-51.

Ali, A., Iqbal, Z., Hassan, S. W., Yasin, M., Khaliq, T., & Ahmad, S. (2013). Effect of nitrogen and sulphur on phenology, growth, and yield parameters of maize rops. Sci. Int., 25(2), 363-366.

Bakht J.S., Ahmed, Trig, M., Akber, H. Shafi, M. (2006). Response of maize to planting methods and fertiliser nitrogen. *Journal of Biological Science* 13:1–4

Bremner, J.M. (1996). Nitrogen-total. In: Sparks, DL, editor. Methods of soil analysis, Part 3, chemical methods. Madison (WI): Soil Science Society of America. pp. 1085– 1121.

Cairns, J. E., Chamberlin, J., Rutsaert, P., Voss, R. C., Ndhlela, T., & Magorokosho, C. (2021). Challenges for sustainable maize production of smallholder farms and rs in subSaharan Africa. Journal of Cereal Science, 101, 103274.

Chinthiya, A., Ganesan, K. N., Ravikesavan, R., & Senthil, N. (2019). Combining ability and association studies on different yield contributing traits for enhanced green cob yield in sweet corn (Zea mays con Varsaccharata). Electronic Journal of Plant Breeding, 10(2), 500-511.

Ciampitti, I. A., Camberato, J. J., Murrell, S. T., and Vyn, T. J., 2013. Maize Nutrient Accumulation and Partitioning in Response to Plant Density and Nitrogen Rate: I. Macronutrients. *Agronomy Journal* 105:783–795.

Fan, P., Ming, B., Anten, N. P., Evers, J. B., Li, Y., Li, S., & Xie, R. (2022). Plastic response of leaf traits to N deficiency in field-grown maize. AoB Plants, 14(6), plac053.

Gee, W.G., and Or, D. (2002). Particle-Size Analysis. p. 255–293. *In*: Dane, J., and G.C. Topp (eds.). *Methods of Soil Analysis. Book Series*: *5. Part 4. Soil Science Society of America*. The USA.

Huang, G., Guo, Y., Tan, W., Zhang, M., Li, Z., Zhou, Y., & Duan, L. (2023). Enhancing maize radiation use efficiency under high planting density by shaping canopy architecture with a plant growth regulator. Crop and Environment.

Kareem, I., Jawando, O. B., Eifediyi, E. K., Bello, W. B., & Oladosu, Y. (2017). Improvement of growth and yield of maize (Zea mays L.) by poultry manure, maize variety and plant population. Repository of Iași University of Life Sciences, ROMANIA https://repository.uaiasi.ro/xmlui/handle/20.500.12811/1017

Kuo, S. (1996). Phosphorus. *In* J. M. Bartels, editor. *Methods of soil analysis. Part 3. Soil*
Science Society of America, Madison, Wisconsin, USA, 869 – 919.Romania

Mrabet, R. (2023). Sustainable agriculture for food and nutritional security. In Sustainable Agriculture and the Environment (pp. 25-90). Academic Press.

Munyasya, A. N., Koskei, K., Zhou, R., Liu, S. T., Indoshi, S. N., Wang, W.,... Xiong, Y. C. (2022). Integrated on-site and off-site rainwater-harvesting systems boost rainfed maize production for better adaptation to climate change. Agricultural Water Management, 269, 107672.

Nelson, D.W., and Sommers, L.E. (1996). Total carbon, organic carbon, and organic matter.
p. 961-1010. In: Black, C.A., ed. *Methods of soil analysis. Part 3. Chemical Methods*. Soil Science of America and American Society of Agronomy, Madison, WI, USA.

NIMET (Nigerian Meteorological Agency), Nigeria (2019). Climate, Weather, and Water Information for Sustainable Development and Safety. Annual Climatic Report.

Raza, M. A., Gul, H., Hasnain, A., Khalid, M. H. B., Hussain, S., Abbas, G.,... & Yang, W. (2022). The leaf area regulates the growth rates and seed yield of soybean (Glycine max l. more.) in the intercropping system. International Journal of Plant Production, 16(4), 639652.

Riadi, M., Amin, A. R., Novianti, F., Musa, Y., Farid, M., Dungga, N. E., & Sahur, A. (2021, July). Response of three maize varieties (Zea mays L.) to different nitrogen dosages. In IOP Conference Series: Earth and Environmental Science (Vol. 807, No. 4, p. 042053). IOP Publishing.

Shah, F., & Wu, W. (2019). Soil and crop management strategies to ensure higher crop productivity within sustainable environments. Sustainability, 11(5), 1485.

Sharafati, A., MoradiTayyebi, M., Pezeshki, E., & Shahid, S. (2022). Uncertainty of climate change impact on crop characteristics: a case study of the Moghan Plain in Iran. Theoretical and applied climatology, 149(1-2), 603-620.

Sithole, M., Ng'ombe, A., Musafiri, C. M., Kiboi, M., Sales, T., & Ngetich, F. K. (2023). The Role of Agricultural Projects in Building Sustainable and Resilient Maize Value Chain in Burkina Faso. Sustainability, 15(24), 16684.

Steensland, A. (2022). 2022 Global Agricultural Productivity Report: Troublesome Trends and System Shocks. Global Agricultural Productivity Report.

Sumner, M.E., Miller, W.P., 1996. Cation exchange capacity and exchange coefficients. In: Methods of Soil Analysis, Part 3, Chemical Methods. Soil Science Society of America and American Society of Agronomy, USA, pp. 1201–1229.

Thomas, G.W. (1996). Soil pH and Soil Acidity. In: Sparks, D.L., Ed., *Methods of Soil Analysis: Part 3 Chemical Methods*, Book Series No. 5, SA and ASA, Madison, WI, 475– 489.

Ukonze, J. A., Akor, V. O., & Ndubuaku, U. M. (2016). Comparative analysis of three different spacings on the performance and yield of late maize cultivation in Etche local government area of Rivers State, Nigeria. African journal of agricultural research, 11(13), 1187-1193.

Brown D., Arnold R., Fletcher D., & Standage M. *Human thriving*. (2017) *Eur. Psychol*. 22, 167–179. doi: 10.1027/1016-9040/a000294.

Carmeli, A., Brueller, & Dutton, J. E. Learning behaviours in the workplace: The role of high-quality interpersonal relationships and psychological safety. *Systems Research and Behavioural Science*, 26, (1). 81-98.

Cohn, M. A., Fredrickson, B. L., Brown, S. L., Mikels, J. A., & . Conway. A. M. (2009), "Happiness unpacked: Positive emotions increase life satisfaction by building resilience." *Emotion,*

Fredrickson, B.L., Brown, S. L., Mikels, J. A., & . Conway, A. M. (2009). Happiness unpacked: Positive emotions increase life satisfaction by building resilience. *Emotion,* Colbert, A. E., Bono, J. E., & Purvanova, R. K. (2016). Flourishing via workplace relationships: Moving beyond instrumental support." *Academy of Management Journal*,

59. (4), 1199–1223. https://doi.org/10.5465/amj.0506

Chen, Z., Eisenberger, R., Johnson, K.M., Sucharski, &. Aselage. J (2009) Perceived organizational support and extra-role performance: Which leads to which?" *Journal of Social Psychology*

Danping Liu, Siwen Zhang, Yanling Wang, & Yufei Yan (2021). The Antecedents of Thriving at Work: A Meta-Analytic Review, *Frontiers in Psychology*. 12, 10.3389/fps.659072

Das, K.V., Carla Jones-Harrell, Yingling Fan, Anu Ramaswami, Ben Orlove, & Nisha Botchwey. (2020) Understanding subjective well-being: perspectives from psychology and public health. *Public Health Reviews*. 41 (25). https://doi.org/10.1186/s40985-020001425

Diener, E. D. Wirtz, W. Tov, C. Kim-Prieto, D. Choi, S. Oishi, & R. Biswas-Diener. (2010) New well-being measures: short scales to assess flourishing and positive and negative feelings. Social Indicators Research. 97(2) 143–156.

Diener, E. S. Oishi, & E. Suh. (2012). Positive emotion offset was essential to human evolutionary success.” Paper submitted for publication, University of Illinois*,*

Dutton, J. E. (2003). Energise your workplace: How to create and sustain high-quality connections at work. San Francisco*, CA: Jossey-Bass,*

Dutton, J. E. & Ragins, B. R. (2007). LEA's organisation and management series, Exploring positive relationships at work: Building a theoretical and research foundation. Lawrence Erlbaum *Associates Publishers*.

Organisation for Economic Co-operation and Development (OECD) 2014. *Better Life Index*,

Elliot, S. J., Dixon, E., & Kangmennang, J. A. (2017). GLOWING Footprint: Developing an Index of Well-Being for low- to middle-income countries. International Journal of WellBeing. 7, 1–27. doi:10.5502/ijw.v7i2.503.

Fairlie, P. (2011) Meaningful work, employee engagement, and other key employee outcomes: implications for human resource development *Advances in Developing Human Resources* 13, 508-525.

Greenhaus & T.D. Allen (2011). Work-family balance: A review and extension of the literature. In J. C. Quick & L. E. Tetrick (Eds.), Handbook of Occupational Psychology. *Washington, DC: American Psychological Association.*

Guocai Wang, Dong Liu, and Xifeng Wang (2011) Effects of perceived organisational support and guanxi on salesperson performance: the mediation of customer need knowledge*. Front. Bus. Res. China.* 5, (33).

Han, H. (2015). The purpose is a moral virtue for flourishing. *J. Moral Educ*. 44, 291-309. doi: 10.1080/03057240.2015.1040383

Harari, M.B., Reaves, A. C., & (Vish) Viswesvaran C. (2016). Creative and innovative performance: A meta-analysis of relationships with task, citizenship, and counterproductive job performance dimensions." *European Journal of Work and Organisational Psychology.*

Junwei Zhang, P. Matthijs Bal, Muhammad Naseer Akhtar, Lirong Long, Yong Zhang, & Ma Zixiang (2018.). High-Performance Work System and Employee Performance: The
Mediating Roles of Social Exchange and Thriving and the Moderating Effect of Employee Proactive Personality. *Asia Pacific Journal of Human Resources* 57, (4). 369395

Kostopoulos K. & Bozionelos N. (2018) Team exploratory and exploitative learning: psychological safety, task conflict, and team performance." *Group & Organisation Management*, 36, 385–415.

Lebreton, J. M., Hargis, M. B., Griepentrog, B., Oswald, F.L., & Ployhart, R.E. (2007). A multidimensional approach for evaluating variables in organisational research and practice." *Personnel Psychology,* 60, 498. doi:10.1111/j.1744-6570.2007.00080.x

Muhammad Shahnawaz Adil, Mayra Bai (2018) Impact of the job demands-resources model on burnout and employees's well-being: evidence from the pharmaceutical organisations of Karachi. *IIMB Management Review*, 30 (2) 119-133. https://doi.org/10.1016/j.iimb.01.004

Norling, L., & Chopik, W. (2020). The association between coworker support and subjective well-being.Frontiers in Psychology, https://doi.org/10.3389/fpsyg.2020.00819

Paterson, T. A., Luthans, well-being. ng, W. (2014). Thriving at Work: Impact of Psychological Capital and Supervisor Support. *Journal of Organisational Behaviour 35* (3) 434–446.

Park, J. H., Newman, A., Zhang, L., Wu, C., & Hooke, A. (2016). Mentoring functions and turnover intention: The mediating role of perceived organisational support. *International Journal of Human Resource Management* 1173–1191.

Pinar, M.(2019) Multidimensional well-being and inequality across the European region with alternative interaction between the well-being dimensions. *Social Indicators Research*. 144 (1), 31–72. doi:10.1007/s11205-018-2047-4

Ryan, M. (2019). rederick C. (2006). On energy, personality, and health: Subjective vitality as a dynamic reflection of well-being. *Journal of Personality, 529–565*

Ryan, R. M., & Deci, E. L. (2017). Self-determination theory: basic psychological needs in motivational development and wellness. New *York, NY: Guilford Press*.

Rhoades, L., & Eisenberger, R. (2002) Perceived organisational support: A review of the literature." *Journal of Applied Psychology*,

Soh, M., Zarola, A., Palaiou, K., & Furnham A. (2016). Work-related well-being. *Health Psychol., 3, no. 1,* 2016. doi: 10.1177/2055102916628380

Spreitzer, G., Bacevice, P., & Garrett, L. (2019). Workplace design, the physical environment, and humans thriving at work. In Organisational Behaviour and the Physical Environment; Ayoko, O.B., Neal, M.A., Eds.; *Routledge: London, UK,*

Towne, S. D., Anderson K.E., Smith M.L., Dahlke D.V., & Kellstedt D. (2015). "Changing organisational culture: using the CEO's cancer gold standard policy initiatives to promote health and wellness at a school of public health." *BMC Public Health, 15, 1, 853–868.*

Van Hees S.G.M., Carlier B., Vossen E., Blonk R.W., & Oomens S. (2022) Towards a better understanding of work participation among employees with common mental health problems: a systematic realist review. *Scand J Work Environ Health.* 48 (3), 173–89.

Zhai Q., Lindorff M., & Cooper B. (2013) Workplace guanxi: Its dispositional antecedents and mediating role in the affectivity-job satisfaction relationship. *Journal of Business Ethics*, 117, 3, (2). 541–551.