Evaluation of synthetic maize (*Zea mays* L.) population for growth and yield in the tropical environment

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Abstract

The average maize yield per hectare in Nigeria and other Sub-Sahara Africa is always less than in developed nation, hence, this research aimed to determine growth factors contributing to the yield performance of synthetic maize populations released for farming in Nigeria and rcommend most yielding variety.Ten synthetic maize varieties obtained from International Institute of Tropical Agriculture (IITA), Ibadan were sown at two seeds per hole in a two row per plot of 5 m length and a spacing of 50 cm intra-row and 75 cm inter-row. The experimental design was Randomized Complete Block (RCBD) of 10 x 3; ten varieties and three blocks. Data were collected from three plants in each row selected randomly from the block. The parameters measured were numbers of leaves per plant, plant heights (cm), stem girths (cm), ear heights (cm), leaf area, cm^2, days to 50% tasselling, days to 50% physiological maturity, cob's length (cm), cob's weight (g), number of grains per cob, number of cob and grain yield (t ha^{-1}). Ambient temperatures and wind speeds and directions were measured at 10.00 h and 14.00 h daily. Both F$_2$TWLY13124 and PVASYNHGACO had same values of 0.45 t ha^{-1} and 2.625 kg as grain yield and cob yield plant^{-1} respectively. However, F$_2$SCA141336 had the highest mean number of leaf plant^{-1}, 12.20; this was 0.83% more than F$_2$TWLY100121 that had 12.10 leaf plant^{-1}. F$_2$TWLY13124 displayed higher number of grain cob^{-1} and longer cob length 778.50 and 20.59 cm respectively. Environmental factors decreased grain yield via decrease in number of leaf plant^{-1}, plant height and number of cob per plant (r= 70.13 to r = 92.31, p<0.05) for the ear height and the cobs' parameters. F_2TWLY13124 and PVASYNHGACO could be suitable, when used in planting, would improve the yield components and grain yield of maize in the study area and contribute significantly to increased production.

Keywords: *cobs, grain yield, growth parameters, population*

1.0 INTRODUCTION

Zea mays L. is monotypic, highly variable, naturally cross pollinated and complex species belonging to the family *Poaceae.* Since the past two decades Maize has become the fourth most consumed staple cereal in the sub-Saharan Africa and Latin America, after sorghum, millet, and rice (Erenstein et al., 2022, FAO, 2012).

In Nigeria, however, white maize is commonly consumed by human while the yellow type has dual purpose as animal feed and human food (IITA, 2022, Cadoni & Angelucci, 2013). These common types also serve food industries particularly in starch production (Dowswell et al., 2019). In 2021, Nigeria produced 12.8 million tonnes of grain from 6 million hectares at a rate of nearly 2.13 t hectare^{-1} (FAO, 2023). The obtained yield was relatively low when compared to maize yield in the developed countries. Among factors considered for the poor performance of Nigeria maize are high dependence on rainfall; poor seed supply and low investment in research (Oyekale et al., 2012). To overcome some of these obstacles, the Federal Government of Nigeria, since 2007 has initiated a plan to double maize production by enabling farmers access to improved seeds and production technologies (DT MAIZE in DTMA, 2014). This initiative also encouraged various research institutes most importantly IITA to engage in the development of high yielding maize varieties.

In addition to quality seed provisition, smallholder farmers in the Tropics are the primary maize producers and their farms are highly vulnerable to climate change, mostly drought, heat and low rainfall (Connolly-Boutin & Smit, 2016; Descheemaeker et al., 2016, FAO, 2018). Also, the accumulated temperature is an important factor for maturation and yield development in maize, thus proper timing of sowing is required for cropping and development especially because of army worm invasion that affect maize growth in Africa (Lamidi and Afolabi, 2016). According to Kamara et al. (2020), maize can tolerate high temperatures up to 35 °C, but yields usually decrease if the high temperature coincides with pollen shedding. Additionally, annual rainfall in the area is expected to increase by 0% to +12% depending on RCP (IPCC, 2013, Almazroui et al.,2020). The impact of these changes in the climate will have a negative effect on maize productivity in the region, where smallholder farms in sub-Saharan Africa (SSA) obtain low maize yields, on average 1.48 tha^{-1} in 2022 (FAO, 2023). The quest to increase maize security in Nigeria and to decry importation, demands more investigations of growth and yield performance of the available synthetic varieies in this region.

2.0 MATERIALS AND METHODS

The field experiment was conducted at the International Institute of Tropical Agriculture (IITA) Ibadan, Southwestern Nigeria. The experimental materials (synthetic varieties) were products of many years of crossing and selection. Synthetic has broad base genetics and comprises 22 inbred lines The study area is located between latitude 7.8717'N; longitude 4.3067’E) and at an elevation of 226 m above sea level. To ascertain the fertility status of the soil before planting, random soil samples were collected from the experimental farm prior to planting for physical and chemical analyses in IITA, Ibadan laboratory, results presented in Table 1. It shows that the soil is sandy-loam, alkaline with high potassium and high calcium exchange capacity.

***Table 1**: Physical and chemical properties of the soil*

Properties	Values
Sand (%)	64
Silt (%)	24
Clay (%)	12
Class	Sandy-loam
pH (H_20)	7.1
Soil organic matter (%)	0.8
Total N (%)	0.067
Available P(Bray-1)(mg/kg)	3.44
Exchangeable cations (Cmol/kg)	0.25
Potassium (Cmol/100g of soil)	0.15
Na(ppm)	0.17
Ca(ppm)	0.08
Mg(ppm)	0.35
CEC (Cmol/kg)	2.83

*CEC:cations exchange capacity

The experiment was laid out in Randomized Complete Block Design using 10 varieties (Table 2) and three (3) blocks. Using a 5 m row, each variety was sown to two rows at a rate of two seed hole^{-1} with spacing of 50 cm intra-row and 75 cm inter-row. The field was well prepared with the aid of smooth ploughing and harrowing at secondary tillage level. NPK 15-15-15 fertilizer was applied at the rate of 200 kg ha^{-1} in three doses. Weeding was carried out manually at 4 and 8 weeks after planting. Three (3) plants per row were randomly selected from the field plot for data collection.

Table 2: *Maize varieties*

S/n	Variety name	Original name	Remarks
1	SAMMAZ 45	AFLATOXIN R SYN-Y2	Resistant to aflatoxin and high grain yield. (6.2 t/ha)
2	SAMMAZ 59	F_2SCA1413-36	High pro-vitamin A content of 16.3 µg/g. (5.0t/ha)
3	SAMMAZ 60	F_2SCA1413-123	High pro-vitamin A content of 15.53µg/g. (5.0t/ha)
4	F_2TWLY 100123	F_2TWLY 100123	Pro-vitamin A maize Hybrid
5	F_2TWLY100121	F_2TWLY100121	High pro-vitamin
6	F_2TWLY 13124	F_2TWLY 13124	High pro-vitamin
7	F_2TWLY 131211	F_2TWLY 131211	High pro-vitamin
8	F_2TWLY131228	F_2TWLY131228	High pro-vitamin
9	PVASYN HGAC2	PVASYN HGAC2	High pro-vitamin
10	PVASYN HGBCO	PVASYN HGBCO	High pro-vitamin

Source: Nigerian Seed Portal Initiative https://www.seedportal.org.ng/search.php

The parameters measured in the experiment include number of leaf plant^{-1}, plant height (cm), ear height (cm), stem girth (mm), leaf area (m^2), days to 50% anthesis, days to 50% silking, anthesis-silking interval (ASI), days to 50% physiological maturity, cob length (cm), cob weight per plant (kg), number of grain per cob, number of cob ha^{-1} and grain yield plant^{-1} were recorded. Each of these parameters was measured as follows:

Plant Height (cm) was determined using metre rule by measuring the plant from the base (near the soil surface) to where tassel's branching begins. Ear height (cm) was also measured from the base of the plant to the node bearing the upper ear. Stem girth (mm) was deterined using venier calliper at middle of the plants. The number of leaf plant^{-1} was determined at flowering by physical counting of the three (3) randomly selected plant in a row. The number of days to 50% tasselling and silking was determined from sowing to the time when 50% of the plants had tassels and silks. The length of five (5) cobs from sampled plants was measured using metre rule Anthesis-silking interval (ASI) was recorded as the time in days between pollen shed and silk emergence. Days to 50% physiological maturity: the numbers of days from planting to the time when the cobs were drooping down. Physiological maturity was recorded when black layer was observed on the middle of kernels of the randomly selected maize plants which signified the disappearance of the kernel milk line (Rahman et al., 2007). Cob weight plant^{-1}: the dry cob weight was taken from 5 cobs of five sampled plant using portable weighing balance (Camry 50 kg weighing scale, model CA277HL) made in Nigeria. The 1000 grain weight: 1000 grains was taken from shelled cobs obtained from the selected plants and weighed using a portable weighing balance Camry 50 kg weighing scale, model CA277HL. Grain yield: this is total grain yield (t/ha) harvested from the rows from each plot at maturity. The cobs were de-husked, shelled threshed, oven-dried to 12-14% moisture content and weighed. The yield was recorded as (t/ha) based on 53,333 plants/hectare planting population employed in the study.

The leaf area of the three (3) randomly selected maize plants was measured by multiplying the length of a leaf by its widest width by alpha according to the formular below:

$Leaf\ Area = \ 0.743\ (L\ x\ W\ x\ O.743)$ .... Mokhtarpour, et al., (2010)

At maturity, total grain yield (t/ha) was determined from the representative plants of each variety by harvesting, de-husking, shelling, threshing and oven-drying to 12-14% moisture content for proper storage. The dried grain was weighed using a portable weighing balance (Camry 50 kg weighing scale, model CA277HL) made in Nigeria.

To determine the response of the varieties to the prevailing field weather condition, ambient temperature and wind speed with wind directions of the field were obtained from the meteorological station in the research area at 10.00 h and 14.00 h daily and reported as monthly mean values.

2.1 Statistical Analysis

Data collected were subjected to one-way analysis of variance (ANOVA) using general linear model (GLM) procedure for Randomized Complete Block Design in SAS (9.2) (SAS, 1999) and Turkey's test of SPSS 17.0. Correlations between different traits were determined using the proc corr procedures of SAS (1999).

3.0 RESULTS AND DISCUSSIONS

3.1 Growth parameters

The variety mean sum of square of the maize synthetic varieties were highly significant ($p \leq 0.05$ and 0.01) for the number of leaf plant^{-1} (3.45), stem girth (21.76), leaf area (85,498.85), plant height (108.05) and ASI (1.81) and at only $p \leq 0.05$ for ear height (383.04 cm) Table 3. Coefficient of variation (CV%) ranged from 0.81 in ASI to 14.85 in leaf area which indicate that there was a greater level of dispersion around the mean values. This further evident why there were significant differeces recorded among the number of leaf, stem girth, leaf area, plant height and ASI.

Table 3: *ANOVA of parameters of growth parameters of synthetic maize*

Source	Df	Number of leaf plant^{-1}	Stem girth, cm	Leaf Area, cm^2	ASI	Ear height, cm	Plant heights, cm
Block	2	0.61	10.11	88.78		72.00	108.05
Varieties (V)	9	3.45**	21.76**	85498.85**	1.81**	383.04*	1017.08**
Error	138	0.67	4.05	7646.41	2.76	103.28	241.61
Total	149						
CV%		7.13	10.71	14.85	0.81	11.11	9.16

** significant at $p \leq 0.05$, **significant at $p \leq 0.01$; CV% = Coefficient of Variation.*

Table 4 shows that the F_2SCA141336 variety had highest mean values for number of leaves and highest leaf area of 12.20 cm and 717.23 cm^2 respectively. F_2SCA141312 has lowest number of leaves, 11.00 cm but with leaf area of 636.10 cm^2. Furthermore, F_2SCA141336 had the highest mean number of leaf plant^{-1}, 12.20; this was 0.83% more than F_2TWLY100121 that had 12.10 leaf plant^{-1}. PVASYNHGACO had the widest stem girth of 20.22 cm, and with tallest ear height of 101.50 cm, these two combinations (widest stem girth and tallest ear height) render it acceptable for farming in this region. Besides, contrasting PVASYNHGACO variety's tallest ear height value (101.5 cm), it is 6.62% more than the next tall ear height, F_2TWLY100121 that was 95.20 cm. Meanwhile F_2TWLY100121 has low growth parameters values compare to PVASYNHGACO and F_2TWLY13124 varieties.

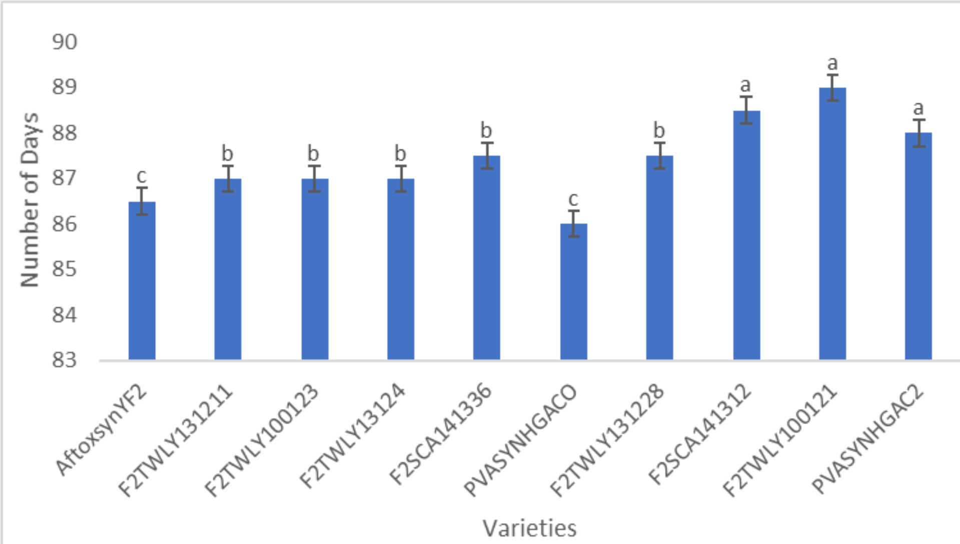
There were statistical differences ($p \leq 0.05$; $p \leq 0.01$) among various mean values for all the growth and yield parameters in all the varieties. The date at which physiological maturity of the cobs occurred was between 86 and 89 days, Figure 1. There were statistical differences among the maize maturity days for different varieties researched upon which mean that different varieties have significant differences ($p \leq 0.05$) on number of days of their maturity, Figure 1. Furthermoe, in

Table 5. There were statistical differences ($p<0.05$) observed across all varieties for all cobs' yield and its associated parameters (cob weight, cob length, number of grain cob^{-1} and number of cobs ha^{-1})

Table 4: *Mean values of growth parameters*

Maize varieties	Number of leaf $plant^{-1}$	Plant Height, cm	Ear height, cm	Leaf Area, cm^2	Stem girth, mm	ASI
AftoxsynYF2	11.10 ± 0.23^{dc}	171.40 ± 4.00^{b}	86.30 ± 2.32^{cd}	671.85 ± 25.52^{ab}	18.96 ± 0.62^{abc}	3.90 ± 1.57^{a}
F_2TWLY131211	11.10 ± 0.27^{dc}	168.50 ± 3.53^{b}	90.40 ± 2.73^{bc}	533.81 ± 17.84^{de}	18.11 ± 0.49^{cd}	2.80 ± 1.80^{b}
F_2TWLY100123	12.00 ± 0.28^{ab}	156.00 ± 3.53^{c}	82.20 ± 2.16^{d}	485.00 ± 20.48^{e}	18.52 ± 0.56^{bcd}	2.80 ± 1.77^{b}
F_2TWLY13124	10.90 ± 0.16^{d}	163.80 ± 3.69^{bc}	92.00 ± 2.78^{bc}	559.30 ± 21.88^{cd}	17.31 ± 0.44^{de}	2.12 ± 1.05^{bc}
F_2SCA141336	12.20 ± 0.18^{a}	169.80 ± 2.96^{b}	92.10 ± 1.17^{bc}	717.23 ± 23.83^{a}	19.81 ± 0.59^{ab}	2.70 ± 1.81^{b}
PVASYNHGACO	11.50 ± 0.15^{bcd}	172.70 ± 4.04^{b}	101.50 ± 3.35^{a}	627.34 ± 26.81^{b}	20.22 ± 0.59^{a}	2.10 ± 0.78^{abc}
F_2TWLY131228	11.50 ± 0.23^{bcd}	175.50 ± 3.95^{ab}	91.50 ± 2.96^{bc}	551.26 ± 18.28^{cde}	16.51 ± 0.29^{e}	2.41 ± 1.06^{abc}
F_2SCA141312	11.00 ± 0.11^{d}	162.60 ± 4.26^{bc}	91.10 ± 2.23^{bc}	636.10 ± 27.33^{b}	19.01 ± 0.54^{abc}	3.10 ± 1.78^{ab}
F_2TWLY100121	12.10 ± 0.16^{ab}	186.70 ± 4.12^{a}	95.20 ± 3.24^{ab}	606.47 ± 18.78^{bc}	20.15 ± 0.46^{ab}	2.00 ± 1.18^{c}
PVASYNHGAC2	11.70 ± 0.25^{abc}	170.90 ± 5.42^{b}	92.30 ± 2.56^{bc}	500.51 ± 20.89^{de}	19.21 ± 0.57^{abc}	3.17 ± 1.70^{ab}

^{abcde} Means in the same column with different superscripts are significantly different ($p<0.05$)



[abc] Means in the same shapefill with different superscripts are significantly different ($p<0.05$)

Figure 1: *Number of days to physiological maturity of the maize cultivars*

Similarly, F_2SCA141336 had the highest mean leaf area, 717.23 cm^2 per maize stand depicting that it was 6.75% more than the next variety AftoxsynYF2 671.85 cm^2 per maize (which is the next higher leaf area). AftoxsynYF2 had 3.90 as the highest ASI, a value that is 2.30% more than the variety PVASYNHGAC2 (3.17 mean value, which was the next ASI value in the research). The growth parameters observed in this study were less than the range of values reported earlier in a study on influence of low and high N on maize yield and growth parameters in the same locality.Comparing both results, it could be seen that for each range of number of leaves was between 5.45 and15.5; plant heights were between 108.55 and 198.47; leaf area was between 441.29 and 695.32 and ASI 2-3 as reported by Afolabi et al (2020). With a range of values, Table 4, number of leaves, 10.90-12.20; plant heights, 156.00-186.70; ear heights, 82.20-101.50; and leaf area, 485.00-717.23; ASI, 2.00-3.90; only ASI and number of leaves were close to the values previously reported by Afolabi et al. (2020).

The highest mean values for all the cob growth parameters recorded was for F_2TWLY13124 with cob weight (2.63 kg), cob length (20.59 cm), number of grain cob^{-1}(778.50), number of cob ha^{-1}(53,333.0) and yield, (0.45t ha^{-1}). The

PVASYNHGACO variety also had high yield of 0.45 tha^{-1} with highest number of cob ha^{-1}(53,442.50) but its cobs were among the shortest, 18.20 cm. Also, F_2TWLY131228 had high yield, 0.44 t ha^{-1} but both cob length (19.48) and number of cobs ha^{-1} (53,098.3) were among the lowest.

There was early tasselling in some of the cultivars namely F_2TWLY131211 (45.75), F_2TWLY100123 (46), PVASYNHGACO (46.5), F_2SCA141312 (46) and PVASYNHGAC2 (46) where days to 50% tasselling were between 45.7 and 48 days, Figure 2. Both the number of days to 50% tasselling and numbes of days to 50% silking were observed to be statistically different for each of the variety and therefore significantly different. Varieties F_2TWLY131211, F_2TWLY100123, F_2SCA141312, PVASYNHGACO and PVASYNHGAC2 have moderately low number of days before physiological maturity was reached, Figure 2.

Table 5: *Grain yield and cob growing parameters for different synthetic varieties*

Treatment	Cob weight (kg)	Cob length (cm)	Number of grains cob^{-1}	Number of cobs ha^{-1}	Yield, t ha^{-1}
Aftoxsyn YF2	2.23 ± 0.27^{b}	19.22 ± 2.32^{bc}	710.00 ± 14.21^{abc}	$53,310.20\pm500.10^{ab}$	0.42 ± 0.01^{abc}
F_2TWLY131211	2.18 ± 0.19^{b}	19.68 ± 2.22^{b}	667.50 ± 9.80^{bc}	$52,999.50\pm412.00^{c}$	0.39 ± 0.02^{bcde}
F_2TWLY100123	2.18 ± 0.11^{b}	18.60 ± 1.28^{cde}	622.50 ± 11.11^{cd}	$53,332,50\pm320.21^{ab}$	0.37 ± 0.02^{cde}
F_2TWLY13124	2.63 ± 0.13^{a}	20.59 ± 3.02^{a}	778.50 ± 12.10^{a}	$53,333.00\pm43.29^{ab}$	0.45 ± 0.12^{a}
F_2SCA141336	2.21 ± 0.11^{b}	17.90 ± 2.01^{e}	650.50 ± 9.98^{cd}	$52,899.90\pm201.12^{c}$	0.40 ± 0.01^{abcd}
PVASYN HGACO	2.63 ± 0.21^{a}	18.20 ± 2.02^{de}	723.50 ± 15.12^{ab}	$53,442.50\pm97.24^{a}$	0.45 ± 0.03^{a}
F_2TWLY131228	2.48 ± 0.11^{a}	19.48 ± 1.19^{b}	690.00 ± 20.22^{bc}	$53,098.30\pm340.12^{bc}$	0.44 ± 0.02^{ab}
F_2SCA141312	2.08 ± 0.12^{b}	18.67 ± 1.71^{cd}	575.00 ± 12.23^{d}	$53,222.22\pm230.14^{b}$	0.38 ± 0.03^{cde}
F_2TWLY100121	2.18 ± 0.01^{b}	18.60 ± 1.22^{cde}	653.50 ± 21.11^{bcd}	$53,101.90\pm230.35^{bc}$	0.35 ± 0.02^{e}
PVASYNHGAC2	2.04 ± 0.02^{b}	17.20 ± 1.26^{f}	677.50 ± 9.89^{bc}	$53,330.45\pm98.97^{ab}$	0.35 ± 0.01^{de}

^{abc} Means on the same column with different superscripts are significantly different ($p<0.05$)

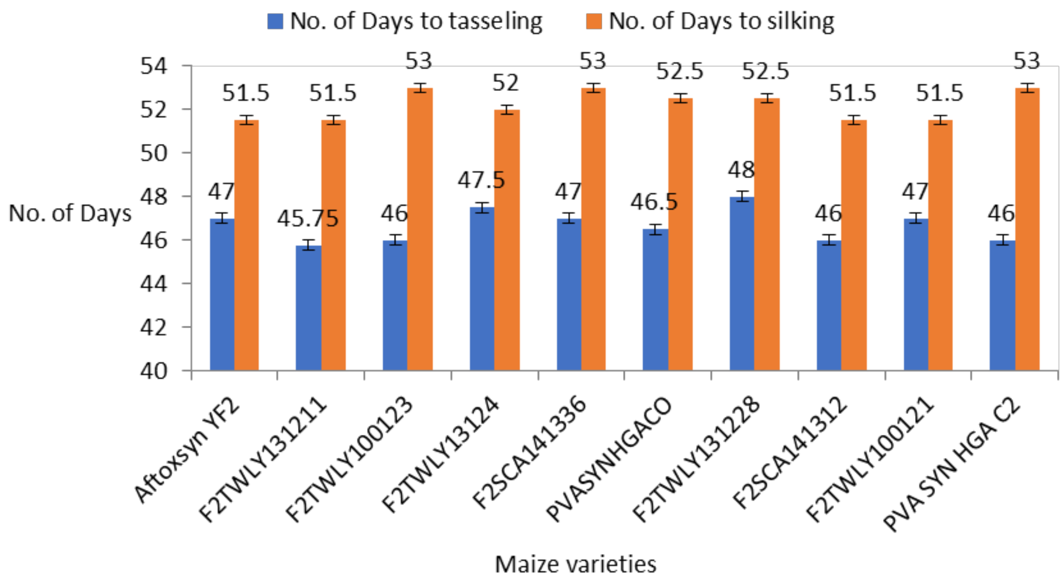


Figure 2: *Number of days to tasseling and to silking of maize varieties*

3.2 Cobs' growth parameters and cumulative grain yield

Statistical differences ($p<0.05$) were observed across all treatment varieties for all the cobs' growing parameters (cob weight, cob length, number of grains per cob and number of cobs per hectare) as shown in Table 5. The highest mean values for all the cob growth parameters recorded were for PVASYNHGACO, however, F_2TWLY13124 also recorded the highest values for cob weight and yield. PVASYNHGACO could be adjudged better than F_2TWLY13124 and all other varieties in the research because of its low ASI value. Also, the highest number of cobs recorded in the plot per hectare was 53,442.5 for PVASYNHGACO variety which was 0.2% more than the closest number of cobs produced in F_2TWLY13124 synthetic variety.

There were higher R^2 values in range between 70.13 and 92.31 for the ear height of the maize and the cobs' growth parameters (cob weight, cob length and cobs' grains number). The low yield recorded was because the number of cobs per hectare was low, the yield recorded was apparently a cob to a maize stand.

3.3 Cumulative yield parameters

There were statistical differences ($p<0.05$) observed across all the varieties for the grain yield ha^{-1}, Table 5. Varieties F_2TWLY13124 and PVASYNHGACO had 0.45 tha^{-1} which was the highest in the study, in addition to 2.63 kg cob weight each respectively in the research. However, PVASYNHGACO could be said to be the highest yield grain producer because, it has highest mean cob length and grains per cob of 20.59 cm and 778.50 grains compare to 18.20 cm and 723.50 grains in F_2TWLY13124 variety. This is because, the more the cob length and the number of grains a cob has, the more the grain yield as they are directly related.

Although, the grains were without impurities and were not affected by any pests (weevils or alike during the research), the yield was generally low compared to earlier experiments on varieties of maize in the country. Both varieties F_2TWLY13124 and PVASYNHGACO with equal cumulative yield 0.45t/ha recorded were low (the yields got were low as they were between 0.35 and 0.45 t/ha) compared to the highest cumulative yield of 3.17 tha^{-1} for high N got by Afolabi et al. (2020) in the same ecological area of Ibadan-Iwo axis in southwestern Nigeria.

3.4 Results of some environmental parameters measured

Between the months of August and October 2021, the environmental parameters namely temperature, relative humidity, wind direction and wind speed, precipitation, atmospheric pressure recorded through the meteorological station in IITA, Ibadan were recorded. Although the precipitation was low, the partial cloudiness of the atmosphere could be said to be accountable for the high humidity ratio with their attendant low temperatures as shown in Table 6.

***Table 6**: Environmental parameters*

Parameters	Monthly mean values		
	August	September	October
Temp. °C(min.)	21.00± 0.04	22.00± 0.02	22.00± 0.02
Temp. °C (max.)	28.00± 0.02	29.00± 0.04	31.00± 0.01
Humidity, %	98.00± 0.25	95.00± 1.03	88.00± 0.16
Precipitation, mm	0.344± 0.04	0.330± 0.02	0.247± 0.04
Atmospheric pressure, mbar	1012.00± 0.27	1012.00± 0.16	1013.00± 0.24
Wind speed, km/h	7.0± 0.14	6.0± 0.24	7.0± 0.12
Wind direction	SW	S, SW	SW

4.0 DISCUSSION

The alkalinity of the soil coupled with high potash is an indication that the alkalinity of the soil could have been decreased since potash reduced alkalinity of the soil. Since different maize cultivars are tolerant to a different levels of alkalinity in the soil, the cultivars in this experiment are tolerant to salkaline soil and therefore the levels of potash in the soil are tolerable. This is important because if a maize cultivar is non-tolerant to saline-alkaline soil, its yield could be reduced, this is because the grain yield increase was more related to the mean decrease of 43% in exchangeable Al, and 51% in H(Wacal et al., 2019, The et al., 2006) and since their values were at tolerant level, this cation exchange capacity value was apparently sufficient for the maize to thrive upon.

Since the soil was alkaline and maize does well in such soil, the temperature range could be said to be at its best as shown by the performances of these synthetic maize, this was earlier observed by Waqas et al. (2021). However, the low yield (0.45 tha^{-1}) got must be from the cultivars genetical built up in them since all other factors of farm practices were normally followed in the experiment.

The dates of tasselling, silking and physiological maturity for the cultivars vary due to the breeds each of the varieties is made up of and the physiology of the different cultivars. Other factors apart from cultivar that could cause delay in tasseling and physiological maturity and days to silking, in this research could be the low temperatures recorded during the experiment that was less than the optimal temperature (33 ^{o}C) (Cleugh *et al*., 1998). This may be so just like application of urea caused delay in days of 50%tasseling and physiological maturity as reported also by Amanullah et al. (2010).

Synthetic maize differed significantly ($p<0.05$) for plant height across the weeks also due to reasons like breeds and environmental parameters. These findings agree with those of Chianu et al. (2012), Oyekola & Fayeun (2019) and Mtyobile (2021) who also found differences in plant heights among hybrids in synthetic maize. This was due to the fact that plant height is a genetically controlled factor (make-up) so the height of different varieties does not remain equal (Oyekola & Fayeun, 2019).

To have good growth parameters, leaf length, number of leaves at the time, maize stem girth and then for its yield to increase, various parameters that make up growth rate must be well established in the crop's genetical make-up (Lamidi & Afolabi, 2016). Since these varieties could not be said not to have gotten these genetical make-ups because of the hybrids that they are, therefore, it is expected that F_2SCA141336 is expected to have higher yield with the highest leaf area value reported and for PVASYNHGACO to have a good yield in relation to higher stem girth and ear height result reported. Oyekola and Fayeun (2019) cited a significant association between ear height and grain yield, thus this could be a reason for PVASYNHGACO to have a considerable high percentage of grain yield than other varieties considering its high ear height. Also, PVASYNHGACO has highest stem girth in the research, this could also be responsible for its high percent grain yield. Besides, the wider stem girth suggests a stronger stem that can support plant to resist late season heavy wind and its consequent effect of lodging of stems and stalking of leaves from main stem. This is because the maize plant will be able to stand firmly and resist lodging and stalking especially if wind speed is less than 50 km/h (Lamidi et al., 2022).

Plant and ear height and the leaf area of maize are very important discriminative characters for choosing better population variety which consequently also determines the yield potential and eventually the economic return. In area where heavy wind is expected prior maize harvest which is predominantly common in this region, depending also on yield, short plant and ear is the preferred type. In this case, a variety such as F_2TWLY100121 that recorded tallest plant and highest ear height may not be recommended for sowing owing to fear of late season lodging and stalking. PVASYNHGACO variety, with its low ASI value, will makes its stem not prone to lodging and leaves not susceptible to stalking. This means that AftoxsynYF2 variety, with highest ASI value, will respond more to stress during flowering than others in the research especially more than F_2TWLY13124 and PVASYNHGACO.

In their report, Billah et al. (2021) concluded from positive correlation observed in hybrid maize yield and height that excess height of hybrid maize led to lodging at pre mature stage during rainy and stormy condition. In another report, Yang et al. (2022) found the yield of short-plant height hybrid was greater than that of high-plant height hybrid, indicating that short-plant height hybrid had better resistance to lodging.

All these have also led to low number of grains as well as yield as there is significant association between all these variables in growing maize with the ear height and the yield. Besides genetics, environmental and nutritional are also factors that can influence several cob parameters (Mtyobile, 2021). Since the goal is to maximize the grain yield, factors such as ear height (Oyekola and Fayeun, 2019), plant density, cob size per plant, and grains per row are important in determining grain size and yield (Mtyobile, 2021). F_2TWLY13124 and PVASYNHGACO had significantly the highest cob length, cob weight and number of grain cob^{-1}, hence validating their high grain yield.

The reason why all the varieties were low in yields, growth parameters and cobs' development might be because the varieties share close history during breeding and because of the same environmental conditions, they were all subjected in the study area. The environmental parameters like temperatures, humidities and wind characters that were apparently moderate throughout the experimental period should be the reason for the statistical differences ($p \leq 0.05$; $p \leq 0.01$) recorded among various growth and yield parameters in all the varieties. This is because temperature influences most plant processes, including photosynthesis, transpiration, respiration, germination, and flowering. It has been established that as temperature increases (up to a cardinal or threshold point), photosynthesis, transpiration, and respiration increase. When combined with day length, temperature also affects the transition from vegetative to reproductive growth, (Oregon State University, 2022; Lamidi et al., 2019).

For any growth to occur in any plant, photosynthesis must be greater than respiration. Therefore as daytime temperatures were too low in the period of the experiment and in the area, they were bound to produce poor growth by slowing down photosynthesis and then later the reproductivity throughout the research period. The number of leaves per plant and leave area reflected the maize plant sunlight harvesting capability, better canopy production and suppression of weed competition consequently affecting the maize dry matter accumulation and grain yield (Nasim et al., 2012). The wider the leaf area of the plant, the higher the potential of plant to maximize the sunlight captured. The synthetic variety that had a high number of leaves and a wide area was F_2SCA141336. The cumulative of all these were revealed in the low growth parameters and cobs' development in these synthetic maize cultivars. The result was the reduced yield got to 0.45 t ha^{-1} grain production when compared to 2-3 t/ha highlighted in the previous experiment by Lamidi (2013).

Moderate wind speeds between 6 and 7 km h^{-1} aid in some morphological and physiological processes like pollination which also could have contributed to the growth components (Lamidi et al., 2019), but contrastingly, the wind speeds were lower than 7 km/h which could have got a negative effect on the maize cultivars during the growing stages, with the complementing low temperatures, all the growth parameters could have been affected. The growth parameters that would first be affected especially was the number of leaves per plant which is a vital indicator of plant growth because leaves are natural and they directly affect the growth and development of plants (Iqbal et al., 2015). Most studies on the response of leaf numbers to plant genotypes have demonstrated that the final leaf number varies between different types of varieties (Liu et al., 2020) as conditioned to environmental factors among others.

5.0 CONCLUSION AND RECOMMENDATION

The result shows that varieties were significantly differs in all parameters. F_2TWLY13124 and PVASYNHGACO have the highest cob parameters which are highly correlated with high grain yield. This made F_2TWLY13124 and PVASYNHGACO a more prolific variety among others, recording the highest grain yield. Also, some environmental factors played important role in the final yield of these synthetic maize varieties.

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