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Assessment of Yield and Nutritional Qualities of Local and Improved Maize Varieties Cultivated in Wukari and Environement of the Nigerian Guinea Savanna Agro-Ecology

Ibirinde, D. O.[1,*], Iliya, M. N.[1], Nuhu, J. A.[1], Balogun, K.[1], Oladokun, L.[2]
[1]Department of Crop Production and Production, Federal University Wukari, Nigeria
[2]Department of Agronomy, Ladoke Akintola University of Technology, Ogbomoso, Nigeria
*Corresponding Author: olalekan@fuwukari.edu.ng

ABSTRACT

Two varieties of maize (quality protein and local) were cultivated and evaluated for nutritional qualities, agronomic traits performance and yield during the 2016 and 2017 cropping seasons at the Teaching and Research Farm of the Federal University Wukari. Wukari is situated on latitude 7^0 52’17.00^{0}N and longitude 9^0 46’40.30^{0}E. It falls within the guinea savannah of North-eastern Nigeria with the annual rainfall of 1058mm-1300mm and relative humidity dropping to about 15%, alongside an annual temperature of 28^{0}C and 30^{0}C. Its characteristic alfisol soil is clay enriched, with subsoil that has relatively high native fertility. Pollination was controlled in order to conserve the genetic purity of

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the two varieties. Data obtained were subjected to analysis of variance (at $p \leq 0.05$), using the 23rd edition of SPSS. Statistical analysis revealed significant differences among the varieties for grain yield, nutritional content, days to tasseling, days to silking, plant height at six weeks after planting, number of seed rows, number of nodes, seed length, hundred seed weight (g) and ear heights. Oba super 2 showed superiority (31.75g) over the local variety for seed yield (100 seed weight). Crude protein concentration in the two varieties varied significantly, with the local maize variety recording a higher value (7.21%).

Keywords: quality protein maize, nutritional qualities, trait performance, yield, humidity.

INTRODUCTION

Maize is the most important cereal crop in sub-Saharan Africa and an important staple food for more than 1.2 billion people in SSA and Latin America, as all parts of the crop can be used for food and non-food products (Jaliya *et al.*, 2015). It emerged third after rice and wheat as the most popular cereal crops that provide nutrient for both human and animal, as it is one of the important raw materials in agro-based industries for the production of alcoholic beverages, starch, protein, food sweeteners and biofuel (Akande and Lamidi, 2006). Several million people, particularly in the developing countries derive their protein and calorie requirement from maize with its high content of carbohydrates, fat and protein (Bello *et al.*, 2012). Bulk of the maize produced in Nigeria has a biological nutritional value of 40% milk and serve as major source of dietary protein for weaning children, sick adult and children or eaten during lean crop production cycle, (Bressani, 1992).

Maize is cultivated all over the world due to its high adaptability to climatic variations. Thus it is one of the cereal crops that can be said to support world food supply (Mohammed *et al.*, 2012). It can be grown on wide variety of soil but perform best on well-drained deep warm loam and silt. Although, most developing countries in the world rely on maize as their staple food, the normal maize has a significant flaw, in that, it lacks the full range of major amino acid, namely lysine and tryptophan (Mbuya *et al.,* 2010). Regardless of its immense importance to animals as well as human, the nutritional value of maize is limited by its low and poor protein concentration. Maize grain protein is low in essential amino acids (lysine and tryptophan). In animal feed, these deficiencies are corrected by addition of supplements that add to the feed cost (Mbuya *et al.,* 2010). Maize varieties may be either hybrid or open-pollinated. Hybrid varieties are made by crossing selected parents (sometimes known as inbred lines) in the field, while open-pollinated varieties (OPVs) are broad populations of many parents. Open-pollinated varieties show greater variability than hybrids, but have the advantage, that, unlike hybrids, their seed may be saved for re-planting without much yield loss (Setimila *et al.,* 2006).

The discovery of the Quality protein maize (QPM) varieties with Opapue-2 mutant gene, containing about twice the levels of lysine and tryptophan and 10% higher grain yield than the most modern varieties of tropical maize, by the International Maize and Wheat Improvement Center (CIMMYT) in 1964, brought a great hope in the effort of its improvement as human and animal nutrition (Akande and Lamidi, 2006; Olakojo *et al*., 2007). High level of these two amino acids not only enhance manufacture of complete proteins in the body, but also offers 90% of the nutritional value of skim milk, thereby alleviating malnutrition (Olakojo *et al*., 2007; Upadhyay *et al*., 2009). QPM has exactly the same qualities as normal maize in grain texture, taste, colour, tolerance to biotic and abiotic stresses as well as high yield (Sofi *et al*., 2009)]. QPM also appear and performs like normal maize and can be reliably differentiated only through laboratory tests (Ganesan *et al*., 2004; Srinivasan *et al*., 2004). Quality protein maize is potentially valuable for feed and food (Scott *et al.,* 2009).

The research work sought to assess and compare the yield performance and nutritional contents of both the locally cultivated maize variety and its hybrid counterpart.

MATERIALS AND METHODS

Experimental materials, site and lay out

The materials consisted of two varieties of maize; quality protein maize (Oba super 2) and a local variety (sourced from the open market), commonly cultivated in Wukari environment. Experiment was conducted during the 2016 and 2017 cropping seasons at the Teaching and Research Farm of Federal University Wukari, Taraba State. Wukari falls within the guinea savannah of North-eastern Nigeria, situated at latitude $7^0$52’17.00^{0}N and longitude $9^0$46’40.30E, with an average annual rainfall of 1058mm-1300mm and relative humidity dropping to about 15%, alongside annual temperature of 28^{0}C and 30^{0}C. Wukari is characterized by rich agricultural land for the cultivation of many crops such as yam, sorghum, maize, rice and other assorted fruits and vegetables (https//en.m.wikipedia.org/wiki/wukarifederation). The field was laid out using the Randomize Complete Block Design (RCBD), with thirty five (35) plant stands per plot at 40cm by 70cm planting distances, with seven (7) plant stands per row and five (5) plants stands per column, sub-plot of Quality protein maize (QPM) of single controlled pollination was replicated four times; sub-plot QPM of triple controlled pollination was also replicated four times, Block of QPM open pollination was replicated four times. The sub-plot of Local maize (LM), single controlled pollination was replicated four times, sub-plot of LM triple pollination was replicated four times, and also the block of LM, open pollination was also replicated four times. In all the blocks, of all treatments, five (5) plants stands were randomly selected for tagged for data collection. And the dimension of block is 4m by 3.6m which give 14.4m^2, and 2m space in between the blocks and 2m space also for border rows.

Data Collection

Relevant data, such as growth parameters, seed parameters and reproductive/yield parameters were taken at different stages of growth. Qualitative and quantitative traits were measured, adopting the design by regional maize course for technician, Arusha Tanzania (1997). Below are the quantitative traits and the instruments used;

Height at six weeks after sowing: measured in meter (m) using metal rule

Height at maturity: Measured in meter (m) using metal rule

Ear height: It is measured in centimeter (cm) with the use of metal rule

Width of ear leaf: Was determined with used of measuring tape, and was measured in centimeter (cm)

Length of ear leaf: Measured in centimeter (cm) using measuring tape.

Ear insertion angle: Measured in degrees (^{0}) using protractor

Ear length: Measured in centimeter (cm) using metal rule

Ear diameter: Using Vanier caliper and record in centimeter (cm)

Ear weight: Measured in gram (g) using sensitive weighing scale

Length of ear peduncle: Using metal rule and was measured in centimeter (cm)

Weight of 100 seeds: Measured in gram (g) using sensitive scale

Length of seed: Record in centimeter (cm) using Vanier caliper

Width of seed: Measured in centimeter (g) with the used of Vanier caliper

Thickness of seed: Measured in centimeter (cm) using Vanier caliper

Number of nodes: All the nodes in the stand were counted and record

Number of tillers: Observation was made on each of the plant stand to determine the tillers population

Number of tassel branches: A count of tassel number of branches was done and record

Number of rows: A count of kernel rows on a cob was also carried out

Days to emergence (DTE): That is, number of days to the emergence of the sown seed

Days to tasseling (DTT): Number of days from sowing to extruding of the tassels

Days to silking (DTS): Number of days from sowing to the visible expression of silk

Days to physiological maturity (DTPM): Number of days taken by the ears to attain physiological maturity, from the sowing day

Ear bagging for hand pollination

As soon as the maize plants started tasseling, proper inspection of the field was carried out and any ear shoot was covered immediately with the ear shoot-bag, firmly, to damage by wind.

Tassel bagging and pollen grain collection

According to Nielson (2010), the tassel is the male reproductive organ of the maize which helps in fertilizing the ovule for kernel development. In order to obtain pollen grain for pollination, the tassel bag was used in covering the tassel. This is done by inserting the tassel inside the readily provided tassel bag and the base of the tassel bag was fold from each corner and stapled at the base, to hold it in place. This operation was normally done in the morning before the pollen grains are dispersed by breeze. To collect the pollen grain, the bagged tassel was carefully bent and shaken, then the clip and tassel was gently removed from the bag that was used and the anther discarded, leaving only the pollen grain, which has a characteristically pale yellow colour.

Pollination

Pollination is the process by which pollen grains are transferred from inflorescence (tassels) to the stigma (silk) of the maize plant. Fertilization does not occur until the male reproductive cells from pollen actually unite with the female reproductive cells from the ovule through the silk. After the collection of pollen grain, the ear was covered to prevent unwanted pollination. The ear shoot-bag was removed from the ear as the silk is already developed and ready to receive pollen for the fertilization of ovule. To have the pollen get into the ear properly, the elongated silk was cut and the collected pollen grain was dusted into the silk. Pollination was conducted very quickly so as to cover it back since the silk is still receptive. Shooted ears were pollinated, as soon as the silk is receptive and tagged accordingly. For those pollinated up to three times as soon as silk are receptive, the first pollination took place, and a day was skipped for the second pollination, a day was skipped again for the third pollination. These operations were carried out in hand pollinated blocks only, for both varieties across all the replications.

Laboratory Analysis

The laboratory analysis (proximate composition estimation) was done using the method of association of analytical chemist.

Moisture content: One gram of sample in pre-weighed crucible was placed in an oven (105^0C) for 24 hours, cooled and reweighed. The percentage moisture was calculated as follows

$$\text{Moisture (\%)} = \frac{w2 - w3}{W_2 - W_1} \times 100$$

Where w_1 is the weight of crucible, w_2 is the weight of crucible after drying at 105^0C and sample and w_3 is the weight of sample after cooling in airtight dessicator.

Ash contents: Ash and mineral content was determined according to AOAC number 932.03 and 984.27 (AOAC 2005). Two gram of samples was added into a pre weighed crucible was incinerated in muffle furnace at 600^0C.

$$\text{Ash (\%)} = \frac{w2 - w3}{W2 - W1} \times 100$$

Where w_1 is the weighed of cleaned, dried, ignited and cooled crucible, w_2 the weight of the crucible and samples after incinerating at 600^0C and w_3 the weight of the crucible and sample after cooling in an airtight homogenized vessel.

Fat and oil: This was estimated using Tecator Soxtec (model 2043 [20430001]; Hilleord, Denmark). A quantity of 1.5g sample mixed with 2.3g anhydrous sulfate was weighed into thimble and covered with absorbent cotton, while 40ml of petroleum ether ($40\text{-}60^0C$ Bpt) was added to a pre weighed cup. Both thimble and cup were attached to the extraction unit. The samples were extracted using ethanol for 30minutes and rinsed for $1^1/_2$hour. Thereafter, the solvent was evaporated from the cup to the condensing column.

Extracted fat in the cup was then placed in an oven at 105^0C for 1 hour and cooled and weighed. Percent fat was calculated as:

$$\% \text{ fat and oil} = \frac{\text{Initial cup weight} - \text{final cup weight}}{\text{Weight of sample}} \times 100$$

Crude protein (CP): Crude protein was determined using the micro Kjeldahl method described by pearson (1976). A volume 10ml H_2SO_4 added to 3g of sample was digested with a Kjeldahl digestor (Model Bauchi 430) for $1^1/_2$ hour. A volume of 40ml water was added distilled using a Kjeldahl distillation unit (Model unit B-316) containing 40% concentrated sodium hydroxide and millipore water. Liberated ammonia was collected in 20ml boric acid with bromocresol green and methyl red indicators and titrated against 0.04 N H_2SO_4. A blank (without sample) was likewise prepared. Percent protein was calculated as:

$$\text{Crude protein } (\%) = \frac{\text{Sample titer} - \text{blank titer x 14 x 6.25}}{\text{Sample weight}} \times 100$$

Where 14 is the molecular weight of nitrogen and 6.25 is the nitrogen factor.

Crude fiber (CF): A weighed crucible containing 1g of the defatted sample was attached to the extraction unit (In Kjeldahl, D-40599; Behr labour- technik GmbH, Dusseldorf,Germany) and into this 150ml of hot 1.25% H_2SO_4 was added and digested for 30minutes, the acid was drained and sample washed with hot distilled water for $1^1/_2$h. The crucible was removed and oven dried overnight at 105^0C cooled, weighed, and incinerated at 550^0C in a muffle furnace (MF-1-02; PCSIR Labs, Lahore, Pakistan) overnight and reweighed after cooling. Percentage extracted fiber was calculated as:

$$\% \text{ crude fibre} = \frac{\text{weight of digested sample - weight of ashed sample}}{\text{Weight of sample}} \times 100$$

Carbohydrate: The carbohydrate content was determined by difference, that is, addition of all the percentage of moisture, fat, crude protein, ash, and crude fiber was subtracted from 100%. This gave the amount of nitrogen-free extract otherwise known carbohydrate. Therefore, it is calculated as:

%Carbohydrate =100 - (%Moisture + %Fat + %Ash + % Crude fibre + %Crude protein)

Data Analysis

Data collected were subjected to statistical analysis, using SPSS software (23^{rd} Edition) mean was separated using least significant difference (LSD).

RESULT AND DISCUSSION

Agronomic Traits of Maize Varieties

Agronomic traits of the two maize varieties under investigation were presented in Table 1. There was a significant difference in the plant height at 6WAP, where QPMCP1 had the highest value (1.29m) and the local maize variety (LMCP1) recorded the least value (0.87m). Generally, plant height determines the growth attained during the growing phase of plants. Value observed for ear height showed significant difference among the varieties. Local maize (LMOP) had the highest value (107cm), while LMCP1 recorded the least (87.75cm). Velci *et al.* (2015), posited that, plant height and ear insertion allowed plant center of gravity to stay more balanced, reducing lodging and stem breakage, thereby favouring nutrient transport and plant production.

The two varieties of maize under investigation showed no significant difference in width and length of ear leaves. Ukonze *et al.* (2016) reported that, leaf number and leaf area are good measures for photosynthetic capacity. Significant difference was observed in ear insertion angle,–with local maize (LMOP) recording the highest value (38.12^0) while quality protein maize (QPMCP1) scored the least value (27.25^0).

Morphometric traits such as ear length, ear weight, ear diameter, number of tassel branches per plant and length of ear peduncle of the assessed maize varieties showed no significant difference in their values. According to an earlier work by Parvez (2007), ear weight, ear diameter and ear length are important ear characters that affect yield efficiency while tassel number of branches, length and weight are important tassel characters that affect yield efficiency as a result of abundant pollen grain produced. The result obtained from the research is in harmony with the finding of Gue *et al.* (1996); Ibirinde *et al.* (2019), that tassel traits affect grain yield either physiologically, by competing for photosynthates, or physically by shading effect. Therefore, in breeding program, an ideal male parent is supposed to have large tassels that can produce large amount of pollen grain whereas an ideal female should partition more towards big ear and hence should possess small tassel.

Number of days to tasselling for the two varieties under investigation showed significant difference in their values, with local variety (LMCP3) attaining tassel extrusion later than the quality protein maize (QPMOP) at 58.8 days and 53.7 days respectively. Significant difference was also observed in the number of days to silking. While quality protein maize produced silk in 55.25 days, the local variety (LMCP3) produced same in 60.50 days. Correspondingly, values recorded for number of days to physiological maturity also expressed significant difference, with the local variety (LMCP1 and LMOP) taking longer (87.7 days), than quality protein maize (QPMOP), which attained physiological maturity earlier (83.20 days). In effect, a direct link was observed between the number of days to tasseling, days to silking and days taken to attain physiological maturity in maize varieties under study, with the quality protein maize showing superiority over its local relative. The result is in agreement with the finding of Jiban (2013) that the silk emerge from the husk about four to eight days after tasseling, also his finding revealed that period from silking to attainment of physiological maturity is 50-55 days, which is in discordance with the result obtained. He also observed that the number of days to tasseling, days to silking and attainment of physiological maturity of maize is reduced or increased depending on the nutrients status of the soil.

Table 1: Agronomic traits of maize varieties

S/NO	TRT	PLH@6WAP (cm)	PHGT	EAR_HGT	WOEL	LOEL	EIA	NOTB	LOEP	EAR_LGT	EAR_WGT	EAR_DMT	DTT	DTS	DTPM
1	**QPMCP1**	1.29^{a}	2.43^{a}	88.00^{b}	9.81^{a}	89.55^{a}	27.25c	15.50^{a}	8.92^{a}	16.67^{a}	137.70^{a}	4.32^{a}	54.00^{b}	56.25b	83.79^{b}
2	**QPMCP3**	1.26^{a}	2.33^{a}	89.65^{b}	9.62^{a}	93.61^{a}	28.62^{bc}	18.81^{a}	9.06^{a}	17.65^{a}	134.56^{a}	4.33^{a}	56.00^{ab}	57.50^{ab}	83.39^{b}
3	**QPMOP**	1.00^{b}	2.28^{a}	95.52^{b}	10.11^{a}	89.66^{a}	30.93^{abc}	18.50^{a}	8.47^{a}	17.25^{a}	145.19^{a}	4.24^{a}	53.75b	55.25b	83.25^{b}
4	**LMCP1**	0.92^{b}	2.35^{a}	87.75^{b}	10.40^{a}	88.32^{a}	35.05^{abc}	20.75^{a}	9.12^{a}	16.20^{a}	144.25^{a}	4.21^{a}	57.50^{ab}	60.25a	84.70^{a}
5	**LMCP3**	0.91^{b}	2.35^{a}	88.10^{b}	10.35^{a}	98.39^{a}	32.81^{ab}	18.00^{a}	8.87^{a}	16.05^{a}	130.42^{a}	4.45^{a}	58.80^{a}	60.20a	83.06^{b}
6	**LMOP**	0.87^{b}	2.26^{a}	107.00^{a}	9.55^{a}	94.92^{a}	38.12^{a}	21.25^{a}	9.25^{a}	16.32^{a}	171.05^{a}	4.35^{a}	56.00^{ab}	58.00^{ab}	84.70^{a}
7	**ST/DEV**	0.20	0.17	84.84	0.68	6.94	5.59	4.10	0.90	1.30	26.50	0.2^{9}	2.84	2.89	0.81

QPMCP1= Quality protein maize controlled single pollination, QPMCP3= Quality protein maize controlled triple pollination, QPMOP= Quality protein maize open pollination, LMCP1= Local maize controlled single pollination, LMCP3= Local maize controlled triple pollination, LMOP=Local maize open pollination, PLH@6WK= Plant height at six weeks, PHGT= Plant height at maturity, EAR HGT= Ear height, WOEL=Width of ear leaf, LOEL=Length of ear leaf, EIA=Ear insertion angle, NOTB=Number of tassel branches, LOEP= Length of ear peduncle, EAR LGT= Ear length, EAR WGT=Ear weight, EAR DMT=Ear diameter, DTT= Days to tasselling, DTS=Days silking, DTPM= Days to physiological maturity.

Mean of yield related traits

Table 2, present the traits that are related to yield of maize varieties under investigation. On the average, number of days to emergence for the two maize varieties was 5.21 days. There was a significant difference in the number of nodes per plant, with the local variety (LMCP1) having the highest number (15.02), while quality protein maize (QPMCP3) recorded the least (13.20). There were no significant difference in the number of tillers, number of cob per plant, and number of seed rows for the two maize varieties. Number of nodes in any plant represents the total leaves produced by it (Ukonze *et al.*, 2016) and increase in number of tillers can increase the number of grain head and/or fill in the spots or the plant stand (http://www.strikepointpioneer.com/do-corn-tillers-help-or-hurt-yield/).

Significant difference was observed in seed length, with the local variety (LMOP) recording maximum value of 0.95cm while quality protein maize (QPMCP3) had 0.56cm, being the least value. However, the average seed length for the analyzed grains was 0.86cm. Other seed metric traits such as seed width and seed thickness showed no significant difference in their values. The work of Teng *et al.* (1992), observed that a single cultivar; characterized by long, wide and heavy grain produced taller plants, with larger leaf area and heavy seeding. This indicated, that, grain length and width can be used to select vigorous seedling between varieties. Long grain was found to be better indicator of leaf area while grain width can be used for germination percentage, hence improving crop stand and yield.

Values obtained for hundred seed weight (HSW) across the different treatments were significantly difference and ranged from 31.75g to 26.76g. The highest value (31.75g) was recorded by QPMCP3, followed by QPMCP1 (28.9g). This suggests that, there is higher concentration of endosperm which contributed to higher seed weight, resulting from frequent dusting of pollen grain and the yield potential of QPM.

Table 2: Mean of yield related traits

S/NO	TRT	DTE	NON	NOT	NOCPP	NOR	SL (cm)	SW (cm)	ST (cm)	HSW (g)
1	QPMCP1	5.00^{a}	13.40^{cd}	0.00^{a}	1.75^{a}	14.50^{a}	0.80^{ab}	0.52^{a}	0.32^{a}	28.90^{ab}
2	QPMCP3	5.50^{a}	13.20^{d}	0.00^{a}	1.75^{a}	13.82^{a}	0.56^{b}	0.58^{a}	0.35^{a}	31.75^{a}
3	QPMOP	5.25^{a}	13.95^{bc}	0.25^{a}	1.75^{a}	14.00^{a}	0.86^{ab}	0.46^{a}	0.38^{a}	28.16^{ab}
4	LMCP1	5.25^{a}	15.02^{a}	0.00^{a}	1.50^{a}	14.50^{a}	0.80^{ab}	0.44^{a}	0.42^{a}	26.81^{b}
5	LMCP3	5.25^{a}	14.37^{ab}	0.00^{a}	1.55^{a}	14.75^{a}	0.89^{a}	0.47^{a}	0.38^{a}	27.64^{b}
6	LMOP	5.00^{a}	14.40^{ab}	0.25^{a}	1.50^{a}	14.70^{a}	0.95^{a}	0.60^{a}	0.31^{a}	26.76^{b}
7	ST/DEV	0.41	0.75	0.50	0.48	0.90	0.21	0.10	0.07	2.74

Where QPMCP1= Quality protein maize controlled single pollination, QPMCP3= Quality protein maize controlled triple pollination, QPMOP= Quality protein maize open pollination, LMCP1= Local maize controlled single pollination, LMCP3= Local maize controlled triple pollination, LMOP=Local maize open pollination, ST/DEV= Standard deviation.

Mineral element content of maize varieties

The maize varieties (Table 3) showed significant difference in their moisture content, where QPMOP emerged first with higher value (8.67%) and LMCP3 recorded the least (8.51%). This result is in accordance with the work done by Bello *et al.* (2012), which revealed that significant difference were normally observed among genotypes of maize for grain moisture. Significant difference was observed in the ash content with the highest value (2.58%) in LMOP, while QPMCP3 and LMCP1 had the least ash percentage of 2.52%. Differences in the crude protein content was significant, where local maize (LMCP1) and local maize open pollination (LMOP) had the highest value of 7.21%CP and QPMOP had the least value. The result is contrary to the research finding of (Vassal, 2005), that QPM varieties differed significantly for grain protein than the normal maize varieties. From the study, significant difference was observed in fiber content with LMOP recording the highest value (1.38%). This outcome is inconsistent with the work earlier done by Omage *et al.* (2009), which stated that QPM varieties are more superior in crude fiber content than local varieties.

There was a significant difference in the carbohydrate content of the assessed maize varieties. QPMCP3 recorded the highest percentage concentration (76.98%), while the least value (76.78%) was observed in LMOP. The result is in consonance with the research finding of Olaoye *et al.* (2009), that, maize genotypes differed significantly in their moisture and carbohydrate content.

Table 3: Percentage concentration of mineral element content of maize varieties

S/NO	GENOTYPE	MC (%)	ASH (%)	FO (%)	CP (%)	CF (%)	CHO (%)
1	QPMCP1	8.54^{cd}	2.54^{b}	3.51^{a}	7.18^{bc}	1.33^{b}	76.89^{bc}
2	QPMCP3	8.64^{ab}	2.52^{b}	3.43^{d}	7.20^{ab}	1.21^{d}	76.98^{a}
3	QPMOP	8.67^{a}	2.57^{a}	3.45^{cd}	7.17^{c}	1.28^{c}	76.86^{c}
4	LMCP1	8.61^{b}	2.52^{b}	3.48^{b}	7.21^{a}	1.30^{c}	76.87^{c}
5	LMCP3	8.51^{d}	2.56^{a}	3.45^{cd}	7.20^{ab}	1.36^{a}	76.91^{b}
6	LMOP	8.55^{c}	2.58^{a}	3.47^{bc}	7.21^{a}	1.38^{a}	76.78^{d}
7	S/DEV	0.06	0.02	0.02	0.01	0.05	0.06

QPMCP1= Quality protein maize controlled single pollination, QPMCP3= Quality protein maize controlled triple pollination, QPMOP= Quality protein maize open pollination, LMCP1= Local maize controlled single pollination, LMCP3= Local maize controlled triple pollination, LMOP=Local maize open pollination, ST/DEV= Standard deviation.

Means and coefficient of variation of yield related traits of maize genotypes.

As presented in Table 4, there was no significant difference among the characters measured except for number of nodes and hundred seed weight. The coefficient of variation, ranged from 2.01% (for seed weight) to 88.89% (for number of tillers). Very high CV value was observed for number of tillers (88.89%) while other traits showed very low variability. Number of cob per plant (29.69%), seed length (26.41%), seed thickness (20.99%), hundred seed weight (9.68%), days to emergence (7.96%), number of rows (6.28%), and number of nodes (5.34%), were coefficient of variation values recorded, above variability. Seed width however, recorded the least variation (2.01%).

Table 4: Means, mean square and coefficient of variation for yield related traits

S/NO	SOV	MEAN	MEAN SQUARE	CV (%)
1	DTE	5.21	0.14^{ns}	7.96
2	NON	14.05	1.86*	5.34
3	NOT	0.68	0.06^{ns}	88.89
4	NOCPP	1.63	0.06^{ns}	29.60
5	NOR	14.37	0.57^{ns}	6.28
6	SL	0.81	0.67^{ns}	26.41
7	SW	0.51	0.17^{ns}	2.01
8	ST	0.36	0.00*	20.99
9	HSW	28.34	13.80^{ns}	9.68

*= Significant at 5% level of probability, ns= Not significant at 5%.

DTE= Days to emergence, NON= Number of nodes, NOT= Number of tillers, NOCPP= Number of cob per plant, NOR= Number of rows, SL= Seed length, SW= Seed weight, ST= Seed thickness, HSW= Hundred (100) seed weight.

CONCLUSION

The quality protein maize variety (Oba super 2) evaluated in the study had superior performance for grain yield, specifically the hundred (100) seed weight. Nutritional qualities of quality protein maize, as observed in the study showed no superiority over its local relative, particularly in crude protein content. In controlled pollination, maize stands that were dusted three times exhibited higher grain weight, which showed that frequent dusting enhances deposition of endosperm in the kernel, resulting in increase in kernel weight. The research further showed that quality protein maize (Oba super 2) is well adapted to the Wukari micro agro-ecology, in terms of stability, trait performance and yield.

It is therefore recommended that the cultivation of quality protein maize should be encouraged in Wukari and neighboring communities. Also, for optimum yield in maize breeding programs, more frequent (thrice or more) dusting of pollen grains should be encouraged.

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