Disease Tolerance and Yield Attributes of Yellow Open Pollinated Maize Varieties in South Western Nigeria

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Abstract: Ten new open pollinated commercial maize hybrids: PVA SYN 16, PVA SYN 9, PVA SYN 12, PVA SYN 14, TEL COMP1-SYN-Y-1, IDO QPM, BODE IGBO QPM, ART/98/SW (Oloyin), PVA SYN 14 and PVA SYN 13 were tested for yield attributes and diseases tolerance against SUWAN-1-SR-1 maize hybrid as check to select the varieties with the highest yield potentials, disease tolerance and good agronomic character. The results showed no significant difference for number of days to 50% tasselling, plant height and ear height. Significant difference were observed for number of days to 50% silking among the varieties tested, PVA SYN 9 silked first at 63.0 days, PVA SYN 16 silked last at 67 days while SUWAN-1-SR-1 took 65.67days to silked. In plant aspect, Bode IGBO QPM had the most pleasing and visual appeal with a rating index of 2.82 indicating a very good performance, followed by five other varieties; PVA SYN 14, ART/98/SW (Oloyin), PVA SYN 9, PVA SYN 16 and PVA SYN 12 all having rating index of 3.17 which indicate good performance while SUWAN-1-SR-1 have a rating index of 3.50 indicating a poor performance. IDO QPM had the highest yield at 4.25t/ha while PVA SYN 9 yielded the lowest at 3.04t/ha. SUWAN-1-SR-1 the check maize hybrid yielded 3.75t/ha lower than IDO QPM (4.25t/ha). All the varieties were tolerant to maize blight, ear rot, maize streak and maize rust but were resistant to *Curvularia spp* infection. They were not also affected by stem and root lodging and all had tight husk covers. Thus, the open pollinated maize varieties (IDO QPM) studied that exhibited good yield and diseases tolerant/resistant traits could be recommended for sustainable maize cultivation and to the breeder to increase the maize gene bank for more research.

[Feyisola R.T., Godonu K.G., Oduwaiye T.R. and Lamidi G.O. **Disease Tolerance and Yield Attributes of Yellow Open Pollinated Maize Varieties in South Western Nigeria.** *Nat Sci* 2016;14(11):23-28]. ISSN 1545-0740 (print); ISSN 2375-7167 (online). http://www.sciencepub.net/nature. 4. doi:10.7537/marsnsj141116.04.

Key word: yield potential, agronomic characters and disease tolerance

1. Introduction

Maize (*Zea mays* L.) is one of the most important food crops after cassava and the most important food grain crop on the African continent in terms of quantity produced and consumed (Tweneboah, 2000; De Vries and Toenniessen, 2001). Its importance has increased as it replaced other staples, particularly sorghum and millet (Smith *et al*., 1994) and has become a major source of cash crop for smallholder farmers (Smith *et al*., 1997).

Maize is a versatile crop, growing across a wide range of agro ecological zones in tropical and subtropical countries of the world (Akinbode, 2010). Although the average yield recorded in the developed countries is up to 8.6 t/ha, production in several areas of developing nation is about 2.8 t /ha (Amos, 2014) and West Africa is still very low 1.3 t/ha (FAO, 2010). Yields obtainable from United States have increased remarkably from 1.6 t/ha in the early 1930's to the current approximately yield of 10 t/ha as a result of adoption of hybrid seed maize (Amos, 2014), whereas yields presently obtainable in Nigeria hover around 1.7 t/ha. This large discrepancy in yield has been ascribed partly to the use of indigenous or open pollinated varieties instead of hybrid maize, traditional farming practices, the use of low-yielding varieties and poor agronomic practices.

Sustainable maize cultivation in tropical Africa is generally constrained by a number of abiotic and biotic factors that significantly reduce the yield (Akande and Lamidi, 2006). Grain yield losses ranging from 0-70% have been recorded owing to diseases incidences which sometimes depend on genetic constitution of the cultivars and stage of growth at the time of infections (Bua and Chelimo 2010). Meanwhile, maize diseases such as maize streak virus, southern leaf blight, maize ear rot and Maize rust prevalence in tropical environment constitute major production constraints in the northern and southern Guinea savanna of Nigeria. They sometimes occur together on maize plants as mixed infections and their occurrence is favoured by warm and humid climatic condition (Olakojo, 2001; Olakojo *et al*., 2005). However, diseases such as ear and kernel rot diseases infection leads to decreased grain yield quality and feeding value of the grains and to some

extent resulted in the production of toxic substances in feed rations. While foliar diseases infection also resulted in reduced level of carbohydrates stored in the grains, resulting in immature and chaffy kernels, ultimately low and poor yields (Ngwira and Khonje, 2005; Olakojo *et al*., 2007). The search for improved grain yield and disease tolerance/ resistance maize varieties therefore become imperative for sustainable and profitable maize production and the adoption disease resistance/tolerance cultivars however remains the most economically viable and practical means of controlling disease transmission and management (Bua and Chelimo 2010). This study therefore, evaluated 10 new open pollinated commercial maize hybrids along with an earlier version SUWAN-1-SR-1 maize hybrid as checks to assess yield performance and tolerance capabilities of the open pollinated maize varieties to five major maize diseases in the agro-ecology suitable for sustainable maize production in the study area.

2. Materials and methods

2.1 Experimental location and design

The trial was carried out in the breeding nursery, southern farm, Institute of Agriculture Research and Training (IAR&T), Moor Plantation, Ibadan, Nigeria. All conventional tillage activities such as ploughing and harrowing were carried out. Thereafter, the experimental site was made into plots with 0.5m discards arranged in Randomized Complete Block Design, replicated three times.

2.2 Germplasm used

Ten (10) new open pollinated maize varieties namely: PVA SYN 16, PVA SYN 9, PVA SYN 12, PVA SYN 14, TEL COMP1-SYN-Y-1, IDO QPM, BODE IGBO QPM, ART/98/SW (Oloyin), PVA SYN 14 and PVA SYN 13 which are commercial hybrids and SUWAN-1-SR-1 hybrid sourced from the seed store of Institute of Agriculture Research and Training (IAR&T), Moor Plantation, Ibadan, Nigeria were evaluated for yield and diseases tolerance.

2.3 Crop managements

Maize planting was done at spacing of 75cm inter row spacing and 50cm intra row spacing with 3 or 4 seeds planted per hole which were later thinned to two (2) vigorous plants per stand two (2) weeks after planting (WAP) in a 5 meters row plot to obtain a plant population density of 55,333 ha^{-1} (Olakojo, 2004). Prior to planting the seeds were dressed with Apron plus to prevent soil borne disease and pest infestation. Pre emergence herbicides (primextra) mixed with contact herbicide (paraquat) was applied at 5 lt/ha and 3 lt/ha respectively. Hand weeding was also done when necessary during the growing period to achieve weed control, improve soil aeration and prevent root lodging and other management practices were done according to the recommendations of the specific areas. NPK 15-15-15 fertilizer was applied at the rate of 30 kg N/ ha and 60 kg of P2O5/ha as basal fertilizer at two weeks after sowing and top dressed with additional N at 60 kg/ha at four weeks after sowing.

2.4 Data collection

The following data were collected based on agronomic traits/characters, yield and disease tolerance.

Plant height: measured with a graduated measuring stick from the base of the plant to the node bearing the flag leaf or the base of tassel.

Ear height: The height of the ear was measured from ground level to the node bearing the uppermost ear from the same plants from which plant heights were recorded were also measured.

Root and stem lodging: This is determined by the actual number of plants that were bending starting from the root-base and stem broken below the ear or bending more than 45□ from the upright position.

Husk cover: Data were taken when ears were fully developed and husk leaves were drying out 3 weeks before harvest. Use a 1 to 5 rating scale where 1 = husks tightly arranged and extend beyond the ear tip and 5 = ear tips exposed. The husk leaves above the ear tip was held by hand to determine how far they extend beyond the ear. Plants with ears that were not well developed were avoided, since the husk leaves on small ears will tend to extend further than those on well-filled ears (Badu-Apraku *et al*., 2012)

Days to silking: The number of days from planting to the time when 50% of plants have emerged silks.

Days to 50% tasseling: The number of days from planting to the time when 50% of plants have tassels and shedding pollen.

At harvest, husk cover as well as plant and ear aspects were rated visually on a scale of 1 to 5 where 1 = clean, uniform, well covered husk, deep greenish plant appearance, large and well-filled ears respectively, and 5 = opened husk, yellowish plant appearance as well as rotten, small and partially filled ears respectively (Bello *et al*., 2012)

Grain yield was obtained from ear weight per plot (assuming 80% shelling percentage) and converted to tonnes per hectare after adjusting to 12.5% moisture content.

Just before flowering, all maize plants from the two middle rows in a plot were observed and counted for the diseases symptoms of the following foliar diseases prevalent in the area: *Curvularia* leaf spot, southern leaf blight, maize rust, ear rust and streak virus Severity of each of the five diseases were evaluated using rating scale of 1-5 where, 1 = no symptom, 2 = slight infection, 3 = moderate infection,

4 = high infection, 5 = very high infection (Bello *et al.,* 2012).

2.5 Statistical analysis

All data collected were subjected to Analysis of Variance (ANOVA) using PROC GLM model of SAS (SAS, 2007) to compute mean squares for each character. The degree of variation was determined using percentage coefficient of variation and significant character means were measure using Least Significant Differences (LSD) at P<0.05.

3. Results

3.1 Number of days to 50% tasseling and silking

Result presented in Table 1 shows that there was no significant difference (P>0.05) among the varieties in days to 50% tasseling. PVA SYN 14 tasselled earliest at 59.3 days followed by IDO QPM at 59.7 days. Significant difference (p<0.05) was observed among the open pollinated maize varieties tested with PVA SYN 9 silking first at 63.0 days followed by TZL and PVA SYN 13, Comp SYN-Y-1 in 64 days. As for number of days to 50% silking, there was significant difference (p<0.05) among the open pollinated maize tested in terms of days to 50% silking. PVA SYN9 silked first in 63.0 days while PVASYN16 silked last in 67 days but SUWAN-1-SR the check took 65.67days to get to 50% silking (Table 1). Earliness is important is an important agronomic trait notably in countries where maize cultivation remains essentially rainfed. The use of early maturing varieties can permit to reduce negative effects of drought and obtain two harvests per year in bimodal rainfall regions, thereby ensuring steady supply and enhance food security.

3.2 Root and Stalk lodging

Result shows no statistical difference (P>0.05) among the varieties in terms of root lodging. However, PVA SYN 14, Bode Igbo QPM and PVA SYN 16 have lodging index 1.0, which was the lowest followed by 5 other varieties: Art/98/SW (Oloyin), TZL Comp SYN-Y-1, IDO QPM, PVA SYN 12 and Suwan 1-SR with 1.3 lodging index (Table 1). But for stalk lodging 7 varieties namely: TZL Comp SYN-1-Y, Suwan 1-SR, ART/98/SW (Oloyin), PVA SYN 16, PVA SYN 13, Bode Igbo QPM and PVA SYN 12 have stalk lodge index of 1.0 each whereas IDO QPM, PVA SYN 14 and PVA SYN 9 were marginally higher with a difference of 0.3 and an index of 1.3 each (Table 1). Root and stalk lodging can cause important yield losses through its action on plant density and the number of harvested ears. Root and stalk lodging may be due to a low mechanical strength of the stalk, an unfavourable architecture and environment such wind and heavy rainfall, insects infestation (stem borers and termite) and diseases damages or the interaction of those factors and others (Arnold and Josephson, 1975). Root and stalk lodging index of maize varieties used in the study show relative resistant index and stand to environmental factor that is generally responsible for the incidence of Root and stalk lodging normally observed in the study area.

3.3 Husk cover

Husk cover obtained from the study was not statistical influenced by the various maize varieties. Irrespective of that, seven varieties had the rating index of 1.0, and the varieties were TZL Comp Syn-y-1, Suwan 1-SR, Art/98/SW-1, PVA SYN 16, PVA SYN 13, Bode Igbo QPM and PVA SYN 12 while trio of IDO QPM, PVA SYN 14, PVA SYN 9 have rating index of 1.33 (Table 1). The maize varieties evaluated in this study shows a good husk cover index, thus tends confers some degrees of protection to the maize plants pest infestation and damage and ultimately improves grains yield. A poor husk cover favours birds and pests damages. A good husk cover (husk going beyond the ear tip and tight husks) confers some level of resistance to maize ears against the maize weevil (*Sitophylus zeamais*) in field (Demissie et al., 2008).

3.4 Plant and ear height

Data obtained from the study indicates that there was no significant difference (P>0.05) among the maize varieties in terms of plant height. TZL Comp SYN-Y-1 was observed to produce maize plant with the shortest height of 112.2cm while the tallest maize variety was PVA SYN 9 with a height of 151.8cm (Table 1). Plant and ear height is regarded as a sign of vigour, though low plant and ear heights are needed in tropical breeding programmes to improve root and stalk lodging resistance or physiological efficiency and facilitate harvesting. Pollak et al. (1991) reported that great height of maize stalks is agronomically deleterious. El-Lakany and Russel (1971) found that plant height was significantly correlated with grain yield. While Bjarnason et al. (1985) showed that plant height reduction improved yield by conferring to the varieties the ability to respond to higher plant densities without lodging and maintaining or reducing barreness level. Plant height is highly correlated with ear height as opined by Kim and Hallauer, (1989); Gyenes-Hegyi et al., (2002) and with vegetative cycle length (Jacquot, 1970).

3.5 Plant and Ear Aspect

Plant aspect is visual measurement of how good and appealing the plants are to the eyes morphologically. The result obtained from the study show that plant aspect was not significantly affected by the maize varieties evaluated (Table 1). Criterion for ear aspect includes uniform cob, kernel setting and filling husk cover and disease tolerance. PVA SYN 14 was most appealing as per ear aspect with lowest

rating index of 2.83, followed by trio of PVA SYN 9, PVA SYN 13, and TZL Comp SYN-Y-1 all have rating index of 3.0. Statistically, there was no significant difference (P>0.05) among the varieties in respect of ear aspect (Table 1).

3.6 Disease tolerance trait

3.6.1 Ear rot

From all the maize varieties evaluated, PVA SYN 9 had the least infection index of 1.0. PVA SYN 14, TZL Comp SYN-Y-1, IDO QPM, PVA SYN 13 and ART/98/SW-1 (OLOYIN) varieties all had infection index of 1.33 while PVA SYN 16, SUWAN-1-SR, PVA SYN 12 and Bode Igbo QPM have infection index of 1.67 respectively. However, no significant difference was observed among the varieties tested (Table 2).

3.6.2 Maize streak virus

As observed in ear rot, there was no significant difference among the varieties under test due to maize streak virus infection. A total of 7 varieties had infection index of 1.0 which include TZL Comp SYN-Y-1, Bode Igbo QPM, ART/98/SW-1, PVA SYN 16, 14 13 and IDO QPM while PVA SYN 9 and SUWAN 1-SR had infection index of 1.33 with only PVA SYN 12 had highest infection index of 1.67 though not statistically different from other varieties (Table 2).

3.6.3 *Curvularia spp*

Curvularia spp least infection index was obtained from TZL Comp SYN-Y-1 (1.0). The result as shown in table 2 indicates there was statistical difference (P>0.05) among the varieties in the trial which clearly point to the fact that the maize varieties suppress infection.

3.6.4 Maize Rust

There was significant difference (p<0.05) among the varieties tested in response to maize rust infection. The least infected was TZL Comp SYN-Y-1 with infection index of 1.0; this was followed by SUWAN 1-SR with infection index of 1.33.

3.6.5 *Helmithosporum spp (*Maize blight)

PVA SYN 16 has least infection index of 1.67 whereas duo of TZL Comp SYN-Y-1 and PVA SYN 9 had infection index of 2.0. Five varieties had infection index of 2.67 and varieties involved were SUWAN 1-SR, PVA SYN 14, Bode-Igbo QPM, PVA SYN 13 and Art/98/SW-1 (Oloyin). When compared statistically there was no significant difference (P>0.05) among the maize varieties in terms of infection (Table 2).

The severity of each of the five maize diseases on the maize varieties and the varietal checks were considerably low. This result suggests a reasonable level of tolerance/resistant to these diseases. Olakojo et al (2005) and Kamara *et al.,* (2004) reported considerable level of tolerance of normal OPV and hybrid maize varieties to these diseases in southwest Nigeria. Resistance/tolerance to maize diseases could be incorporated into susceptible cultivars through recombination with resistant/ tolerance normal maize varieties (Akande and Lamidi, 2006).

3.7 Grain yield (t/ha)

Result on yield obtained from the study was presented in Table 3. Yield obtained was significant influenced (p<0.05) by the different maize varieties tested. IDO QPM yield most with a yield of 4.25t/ha which was significantly higher than the 2 lowest recorded by PVA SYN 9 and PVA SYN 12 with a yield of 3.04 3.17t/ha respectively. TZL Comp SYN-Y-1 4.13 was the next to IDO QPM in terms of yield potential. PVA SYN 13 (3.77t/ha) SUWAN 1-SR (3.75t/ha) check, ART/98/SW-1 (OLOYIN) 3.73 t/ha while Bode Igbo QPM and PVA SYN 14 had 3.59 and 3.42 t/ha respectively. The trial check SUWAN 1-SR out yielded six varieties and was equally out yielded by three varieties namely: PVA SYN 16 (3.77Ha), TZL Comp SYN-Y-1(4.14Ha) and IDO QPM (4.25Ha) respectively (Table 1). Grain yield is a complex trait. It is the product of several components including the number of ears per plant, the number of grains per ear and the mean grain weight. According to Ordas et al. (1987) and Claudio-Jobet and Patricio Barriga, (1988) its heritability is low (0.09 to 0.38).

Table 1: Mean value of open pollinated maize varieties agronomic parameters

S/N	Varieties	50% tasseling	50% silking	Plant height	Ear height	Plant aspect	Ear aspect	Husk cover	Root lodging	Stem lodging
1	ART/98/SW/OLOYIN	62.333a	65.667a	146.07a	56.20a	3.1667a	3.5000abc	1.0000a	1.3333a	1.3333a
2	BODE-IGBO QPM	60.333a	64.333ab	140.33a	55.53a	2.8333a	3.6667ab	1.0000a	1.0000a	1.3333a
3	IDO QPM	59.667a	65.000ab	125.18a	44.03a	3.5000a	3.1667abc	1.0000a	1.3333a	1.0000a
4	PVA SYN 12	62.667a	65.000ab	133.20a	55.10a	3.1667a	3.6667ab	1.6667a	1.3333a	1.0000a
5	PVA SYN 13	63.000a	64.000ab	151.80a	64.20a	3.4000a	3.0000bc	1.0000a	2.0000a	2.0000a
6	PVA SYN 14	62.000a	65.667ab	131.80a	58.40a	3.1667a	2.8333c	1.0000a	1.0000a	1.0000a
7	PVA SYN 16	63.333a	67.000a	140.90a	58.63a	3.1667a	3.3333abc	1.0000a	1.0000a	1.3333a
8	PVA SYN 9	61.667a	63.000b	135.40a	61.13a	3.1667a	3.0000bc	1.3333a	2.0000a	2.0000a
9	SUWAN-1-SR	62.000a	65.667ab	136.07a	54.53a	3.5000a	3.8333a	1.3333a	1.3333a	1.6667a
10	TZI COMP SYN-1	61.333a	64.000ab	112.17a	84.00a	3.5000a	3.0000bc	1.0000a	1.3333a	1.3333a

Mean with the same letter(s) in the same column are not significantly different from one another at p<0.01- 0.05

Table 2: Mean value of disease incidence on open pollinated maize varieties

S/N	Varieties	Ear rot	Maize streak	Maize rust	Maize blight	*Curvularia spp*
1	ART/98/SW/OLOYIN	1.3333a	1.0000a	1.6667abc	2.6667a	1.6667ab
2	BODE-IGBO QPM	1.6667a	1.0000a	1.6667abc	2.6667a	1.3333ab
3	IDO QPM	1.3333a	1.0000a	1.6667abc	2.8333a	1.6667ab
4	PVA SYN 12	1.6667a	1.6667a	2.6667a	3.0000a	1.6667ab
5	PVA SYN 13	1.3333a	1.0000a	2.3333ab	2.6667a	1.3333ab
6	PVA SYN 14	1.3333a	1.0000a	2.3333ab	2.6667a	2.0000a
7	PVA SYN 16	1.6667a	1.0000a	1.6667abc	1.6667a	1.6667ab
8	PVA SYN 9	1.0000a	1.3333a	2.1667ab	2.0000a	1.3333ab
9	SUWAN-1-SR	1.6667a	1.3333a	1.3333bc	2.6667a	2.0000a
10	TZI COMP SYN-1	1.3333a	1.0000a	1.0000c	2.0000a	1.0000b

Mean with the same letter(s) in the same column are not significantly different from one another at p<0.01- 0.05

Table 3: Mean yield value of open pollinated maize varieties

S/N	Varieties	Grain yield
1	ART/98/SW/OLOYIN	3.733abc
2	BODE-IGBO QPM	3.5893abc
3	IDO QPM	4.2477a
4	PVA SYN 12	3.1707abc
5	PVA SYN 13	3.3693abc
6	PVA SYN 14	3.4217abc
7	PVA SYN 16	3.7667abc
8	PVA SYN 9	3.0430c
9	SUWAN-1-SR	3.7453abc
10	TZI COMP SYN-1	4.1357ab

Mean with the same letter(s) in the same column are not significantly different from one another at p<0.01- 0.05

4.0 Conclusion

Findings from the study indicate that IDO QPM variety showed promising performances in terms of agronomic trait, yield potential and disease tolerance/resistant compared to other varieties evaluated and PVA SYN 9 is the least performed variety. Thus, the open pollinated maize varieties (IDO QPM) studied that exhibited good yield and diseases tolerant/resistant traits could be recommended for sustainable maize cultivation and to the breeder to increase the maize gene bank for more research.

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