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PARTICIPATORY ON-FARM EVALUATION OF STRESS TOLERANT MAIZE VARIETIES AND HYBRIDS IN SOME NORTHERN STATES OF NIGERIA

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Abstract: ***Maize is one of the most planted crops in Nigeria and it accounts for the largest share of the country's coarse grain production. Maize farming is carried out in nearly all the geographical zones in Nigeria. However, the bulk of the country's maize production is concentrated in Kaduna, Katsina, Niger, Plateau, Taraba, Kano and Oyo. These maize producing states accounts for nearly two-third (64%) of maize produced in Nigeria. Current maize yield averages 1.7 t/ha and is barely sufficient for the region's requirements due to drought, striga infestation and low N stresses. The objective of this study was to compare new stress tolerant maize hybrids and open pollinated varieties (OPVs) against the best released commercial varieties in Nigeria using farmer participatory approach and to validate on-station results. Maize varieties were simultaneously selected on-station from the different agro-ecology in Nigeria during the 2019/2020 and 2020/2021 seasons. During the season, 12 promising stress tolerant maize hybrids and OPVs among which are extra-early, early and intermediate were selected from the on-station based on their mean grain yield and stability. These selected varieties were compared with the best commercial check varieties on-farm across locations in Nigeria in a randomized complete block design. The genotype + genotype x environment comparison biplot showed hybrid AS1909-5, EWTH-14 together with other new stress tolerant hybrids and OPVs to be stable and high yielding on-station across locations compared to the commonly grown checks. This indicated that hybrid AS1909-5 and EWTH-14 possesses beneficial alleles that contributed to the observed superior performance when compared to the other hybrids.The new stress tolerant hybrids showed a yield advantage over the commercial check varieties both in the extra-early, early and the intermediate maturing categories, and the gains were bigger under stress conditions. Under farmers' fields, DT STR Syn/TZL Comp.-W, 2015 DTE STR-Y Syn, AS1909-5, AS2001-16, EWTH-14 and EEPVAH-95 were high yielding and stable across locations and recommended for release.***

• Introduction

• Maize (*Zea mays* L.) is a major staple food crop in Nigeria. Its high energy content has made it very important in both human diet and animal feed. Maize is rapidly replacing traditional cereals such as sorghum (Sorghum bicolor (L.) Moench) and millet (Pennisetumglaucum (L.) R.Br.) in the guinea savannas region of Nigeria, where there is good access to fertilizer inputs and markets (Badu-Apraku *et al.*, 2003). Its ability to thrive in a wide range of soil types and many agro-ecological zones may be partly responsible for its increasing popularity over the traditional cereals of the region. Nigeria is Africa's second largest maize producer after South Africa and the 14th largest producer globally. The total maize production in 2019 is about 11 MMT harvested from over 6.8 million hectares of land. This production level represents a growth rate of 49% relative to the production level recorded a decade earlier (FAOSTAT, 2019). However, the association of maize farmers in Nigeria gave a far higher production figure of 20 MMT in 2019 (Commodity-port.com).

• Material and method

• Training of extension agents and participating farmers took place at their respective communities.

• On-farm evaluation of stress tolerant materials were conducted. The trials were conducted on farmers' fields to test, demonstrate and evaluate the performance of promising stress tolerant maize varieties and hybrids across Kaduna, Katsina, Kano, Bauchi and Jigawa States. Three genotypes plus farmers' variety in some cases were evaluated using 20m x 20m plot size per farmer and each farmer served as a replicate. The on-farm trials were established with 10 to 15 farmers from each state out of the two to three communities that were selected per State. 50 farmers were involved in the on-farm trials in the five States. Two to three sets of open pollinated varieties and hybrids were included, extra-early, early and intermediate/late maturing groups were evaluated. The hybrids and open-pollinated varieties tested in the on-farm trials are presented in Table 1. Three seeds per hill were planted and the seedlings were thinned to two/stand about 2 weeks after emergence to give a final plant population density of about 53,333 plants ha^{-1}. A blended fertilizer (NPK 20:10:10) was applied at the rate of 60 kg N ha^{-1}, 60 kg P ha^{-1} and 60 kg K ha^{-1} two weeks after planting (WAP) for all experiments. An additional 60 kg N ha^{-1} urea was top-dressed three weeks later. In all the trials, the field was kept weed-free through the application of a mixture of gramoxone and primextra at 5 l ha^{-1} each of gramoxone and primextra in some cases. Subsequently manual weeding was done as necessary to keep the trial fields weed-free. A total of 69 on-farm trials in the five states were conducted.

• Results and discussions

Grain yield and other agronomics traits of intermediate maize OPV evaluated across all locations in northern guinea savanna of Nigeria during 2022 raining season.

Enotype	Days Pollen	Days Silking	Plant Height	Ear Height	Husk Cover	Plant Aspect	Ear Aspect	Ear per Plant	Anthesis Silking Interval	Grain Yield	Fermo Ranki
DT STR Syn/TZL Comp.-1-W	60.98	62.88	187.26	88.93	1.39	1.83	1.81	1.00	1.90	4883.11	1
TZE Comp.3 DT/STR Syn	61.29	62.98	191.55	86.31	1.54	2.10	2.04	1.00	1.69	4096.87	3
SAMMAZ 51	60.64	62.55	185.60	87.74	1.50	1.94	1.99	1.00	1.90	4374.81	2
Mean	60.97	62.80	188.14	87.66	1.48	1.96	1.95	1.00	1.83	4451.60	
CV	2.02	1.93	3.23	6.20	11.35	12.20	14.19	0.00	37.61	12.65	
LSD	0.92	0.90	4.54	4.09	0.12	0.18	0.20	0.00	0.51	421.20	

Grain yield of intermediate maize OPV evaluated across all locations in northern guinea savanna of Nigeria during 2022 raining season.

Genotype	Gwarzo	Soba	Zaria	Agege	Bauchi	Malumfashi	Birninkudu	Across
DT STR Syn/TZL Comp-1-W	5480	2432	2233	5857	6433	4129	7618	5065
SAMMAZ 51	5051	2183	1091	5756	5652	3789	6741	4549
TZE Comp.3 DT/STR Syn	5242	1638	1451	5706	4150	4514	6338	4527
Grand Mean	**5258**	**2085**	**1451**	**5773**	**5412**	**4144**	**6899**	**4714**
LSD	**1276**	**1545**	**1116**	**2787**	**1356**	**1208**	**1025**	**592**
CV	**11**	**27**	**5**	**17**	**9**	**13**	**5**	**6**
Heritability	**0.0**	**0.1**	**0.1**	**0.0**	**0.9**	**0.3**	**0.9**	**0.8**
Genotype	**ns**	**ns**	*****	**ns**	**ns**	**ns**	**Ns**	**Ns**

Grain yield and other agronomics traits of intermediate maize hybrid evaluated across all locations in northern guinea savanna of Nigeria during 2022 wet season.

Genotype	Days Pollen	Days Silking	Plant Height	Ear Height	Husk Cover	Plant Aspect	Ear Aspect	Ears per Plant	Anthesis Silking Interval	Grain Yield	Farmo Ranki
AS1909-5	59.36	61.47	183.89	86.25	1.53	1.96	1.89	1.00	2.11	3847.24	1
M1124-12	59.92	61.61	185.28	87.08	1.67	1.93	1.96	1.00	1.69	3348.85	3
SAMMAZ 61 (M1526-1)	58.97	60.94	181.94	87.08	1.72	1.96	1.96	1.00	1.97	3216.53	2
Mean	59.42	61.35	184.56	87.44	1.64	1.91	1.90	1.00	1.93	3442.17	
CV	1.46	1.47	3.08	5.86	15.85	10.07	12.91	0.00	23.34	15.83	
LSD	0.666	0.693	4.367	3.929	0.199	0.148	0.188	0.00	0.346	418.12	

Grain yield of intermediate maize hybrid evaluated across all locations in northern guinea savanna of Nigeria during 2022 wet season.

Genotype	Days Pollen	Days Silking	Plant Height	Ear Height	Husk Cover	Plant Aspect	Ear Aspect	Ears per Plant	Silking Interval	Grain Yield	Farmers Ranking
A1807-20	59.70	61.37	184.33	88.97	1.60	1.87	2.07	1.00	1.67	3938.21	1
AS2001-16	59.97	61.93	185.83	89.67	1.50	1.93	1.87	1.00	1.97	3940.81	2
SAMMAZ 58 (M1628-3)	58.97	61.07	183.67	84.83	1.63	1.95	1.98	1.00	2.10	3493.46	3
Mean	59.54	61.46	184.61	87.82	1.58	1.92	1.96	1.000	1.91	3790.83	
CV	1.60	1.58	2.78	3.62	12.73	14.25	8.39	0	35.99	20.14	
LSD	0.79	0.805	4.3411	2.7289	0.1697	0.2218	0.1342	0	0.5756	674.65	

Grain yield of intermediate maize OPV evaluated across all locations in northern guinea savanna of Nigeria during 2022 raining season.

Genotype	Gwarzo	Birninkudu	Gwarzo	Malumfashi	Soba	Zaria	Across
AS1909-5	4649	5736	4649	3409	2977	2453	3842
M1124-12	3242	6068	3242	3423	2687	1939	3292
SAMMAZ 61 (M1526-1)	2683	6330	2683	3174	2646	1693	3174
Mean	**3525**	**6045**	**3525**	**3335**	**2770**	**2028**	**3436**
LSD	**1056**	**1384**	**1056**	**1848**	**1539**	**1443**	**426**
CV	**13**	**8**	**13**	**24**	**20**	**16**	**5**
Heritability	**0.9**	**0.0**	**0.9**	**0.0**	**0.0**	**0.0**	**0.9**
Genotype	******	**Ns**	******	**ns**	**ns**	**ns**	*****

Grain yield of intermediate maize OPV evaluated across all locations in northern guinea savanna of Nigeria during 2022 raining season.

Genotype	Gwarzo	Soba	Zaria	Agege	Bauchi	Across
A1807-20	6141	2199	1857	3973	5522	4502
AS2001-16	5823	3085	1516	3270	6010	4490
SAMMAZ 58	4596	2621	2170	3097	4984	3875
Mean	**5520**	**2635**	**1848**	**3447**	**5505**	**4289**
LSD	**1747**	**410**	**345**	**2096**	**2456**	**480**
CV	**14**	**6**	**4**	**27**	**20**	**5**
Heritability	**0.7**	**1.0**	**0.0**	**0.0**	**0.0**	**0.9**
Genotype	**na**	*****	**ns**	**ns**	**Ns**	*****

• Conclusions

• Results of the combined analysis across locations allowed identification of high yielding varieties and hybrids with stable performance across all the locations. Based on the performances of some of these varieties and hybrids across all locations such as the intermediate hybrid (AS1909-5and AS2001-16), intermediate OPV (DT STR Syn/TZL Comp-1-W), early OPV (2015 DTE STR-Y Syn), early hybrid (EWTH-14) and extra early hybrid (EEPVAH-95) in the overall on-farm trials, thus, these varieties and hybrids are therefore, recommended for release and registration in Nigeria. These should also be promoted for commercialization and adoption in order to address the challenges facing maize production in Sub-Saharan African agriculture such as the emerging threats from biotic and abiotic factors due to climate change.