Tropical and Subtropical Agroecosystems

YIELD AND DISEASE EVALUATION OF SOME IMPROVED MAIZE (*Zea mays* L) VARIETIES IN SOUTH WESTERN NIGERIA.

[RENDIMIENTO Y RESISTENCIA A ENFERMEDADES DE VARIEDADES MEJORADAS DE MAÍZ (Zea mays L) EN EL SUROESTE DE NIGERIA]

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SUMMARY

Six maize varieties and one check entry were evaluated in year 2001 and 2002 in six locations of the south western Nigeria for yield potential, adaptation and diseases resistance. Location, variety, year of evaluation as well as variety*year interaction were significant for grain yield (P<0.05). The interactive effect of year and location for grain yield revealed different genotypic performance of the varieties tested with DMR-ESR-W and EV 8443 DMR-SR being responsible for the significant differences obtained in both years of evaluation. Mean grain yield across varieties was significantly higher in 2001 than 2002 probably as a result of higher precipitation and humidity of 2002. EV 8443-DMR and TZPB-SR gave the highest grain yields with yield advantages of 204% over the check entry. The varieties tested were generally resistant to streak and downy mildew diseases except TZPB-SR and TZB-SR (even though high yielding) were slightly susceptible to downy mildew. The improved maize varieties tested were generally suitable for south western Nigeria. They were equally fairly resistant to the prevailing diseases of the region. Varieties such as DMR-ESR-W and EV8443DMR-SR that appears to be sensitive to seasonal variations may be restricted to suitable environments.

Key words: Maize yield, disease resistance, adaptation.

RESUMEN

Se evaluó el rendimiento, adaptación y resistencia a enfermedades de seis variedades de maíz y un control en los años 2001 y 2002 en seis localidades del Suroeste de Nigeria. La localidad, variedad, año de evaluación y la interacción variedad*año tuvieron efecto significativo (P<0.05) sobre la producción de grano. El efecto de la interacción reveló diferencias genotípicas de las variedades probadas, siendo las variedades DMR-ESR-W y EV 8443 DMR-SR las responsables de los efectos observados. La producción de grano fue más alta en el año 2001 probablemente por una mayor precipitación pluvial y humedad durante el año 2002 que parecen haber favorecido la aparición de enfermedades. EV 8443-DMR y TZPB-SR tuvieron los mayores rendimientos de grano con una producción de 204% sobre la variedad control. Las variedades fueron generalmente resistentes para las enfermedades evaluadas excepto por TZPB-SR y TZB-SR. Las variedades evaluadas fueron en general adecuadas para la región. Siendo en general igualmente resistentes a las enfermedades de la región. Variedades como DMR-ESR-W y EV8443DMR-SR que parecen ser sensibles a las variaciones estacionales deben ser restringidas a ambientes adecuados.

Palabras clave: Rendimiento, resistencia a enfermedades, adaptación.

INTRODUCTION

Maize is one of the most important cereals in subtropical Africa. It is of significant importance in terms of its utilization potentials and wide adaptation. It therefore forms part of the farming system in many agro-ecologies where rainfall and soil nitrogen supplies are adequate. In Nigeria, its cultivation cuts across the whole agro-environment ranging from the costal forest region through the southern Guinea savanna (SGS) to the Northern Guinea Savanna (NGS). For example, Philip *et al*. (2000) reported maize adoption rates of 18-52% in some states in the NGS of Nigeria where maize was hardly grown in the 1970s. Although, in Nigeria, production is gradually increasing with the introduction of maize to NGS, the domestic supply was unable to match up with the demands due to lack of improved high yielding varieties.

Similarly, maize diseases of the tropical environment such as maize streak virus (MSV) transmitted by *Cicardulina spp*, downy mildew disease (DM) caused by *Peronosclerospora sorghi* (Fajemisin *et al*., 1985);

maize leaf rust (*Helminthosporium maydis*); maize lead blast (*Pucinia polysora*); maize leaf spots (*Curvularia lunata*) and maize ear rot (*Fusarium moniliforme*) are on the increase (Olakojo and Iken, 1999). Other limiting factors include stem borer pests caused by *Eldana* and *Buseola* spp especially in the southern parts of Nigeria while *striga* parasitic weeds (*S. hermonthia and S .lutea*) constitute the major production constraint in the northern and southern guinea savanna of Nigeria (Olakojo *et al.,* 2001).

The quest for improved high yielding and disease/pest resistant maize varieties therefore becomes imperative for profitable maize production. Research efforts at national, regional and international levels often lead to the release of new genotypes that must be tested in various agro-ecological zones for adaptation, yield potential and disease reactions before their release to farmers (Olakojo and Iken 2001). For example, Asman (1991) registered three maize inbreds with resistance to the prevailing diseases of United State of America with a view to increasing production, Shumba (1986) also suggested the use of high yielding maize varieties for enhancing food security in Zimbabwe. The objective of this study therefore, was to evaluate newly developed maize varieties in different agro-ecological zones of south western Nigeria for yield performance, disease resistance and adaptation.

MATERIAL AND METHODS

Six improved maize varieties and one check entry were evaluated in 2001 and 2002 in six locations representing different agro-ecological zones of the South western Nigeria for yield performance, disease reaction and adaptation. Table1 shows the description of the locations used for the evaluation, while varieties evaluated are presented in Table 2. Trials were located in Akure, Ikenne, Ibadan, Ilorin ,Benin, and Osogbo in Ondo, Oyo, Kwara, Edo and Ogun states of Nigeria respectively.

Table 1: Description of locations used for evaluation

Location	Latitude	Longitude	Altitude (masl)	Mean Rainfall (mm)	Annual	Mean relative humidity	
				2001	2002	2001	2002
Ibadan	7^{0}26'N	3^{0}54'N	150.0	1144.0	1407.0	68.40	66.25
Akure	50^{0}8'N	5^{0}14'E	300.0	1577.9	1894.8	63.40	65.20
Ikenne	6^{0}54'N	3^{0}42'E	60.0	1600.0	1677.0	61.40	64.30
Ilorin	5^{0}30'N	4^{0}25'E	200.0	1079.0	1534.0	51.08	64.30
Benin	6^{0}20'N	5^{0}30E	78.0	1530.0	1610.0	51.08	52.20
Osogbo	7^{0}33'N	4^{0}15'E	280.0	1120.0	1124.0	54.30	55.20

Masl-Meters above sea level

Table 2: Improved open pollinated maize varieties and important agronomic characteristics.

Variety	Days to maturity	Grain colour	Disease resistance
DMR-ESR-W	78	White	DMR,SR
DMR-LSR-W	87	White	DMR,SR
EV8443 DMR-SR	90	"	DMR,SR
WY (check)	120	Yellow	DMS,SR
DMR-LSR-Y	89	Yellow	DMR,SR
TZPB-SR	120	White	DMS,SR
TZBR	90	White	DMD,SR

DMR-Downy mildew resistant
DMS-Downy mildew susceptible
SR-Streak resistant

A randomized Complete Block Design with four replications was used in each of the six locations. Plantings were done on 3 x 5m plots using two seeds per hill at the spacing of 75 x 50 to obtain an optimum plant population of 53,333 per hectare. Weeds were chemically controlled using 5 L/ha gramoxone (300g/L paraquate) with a supplementary manual weeding six weeks after planting (WAP). Inorganic NPK fertilizer was applied four WAP at the rate of 80kg N, 40kg P and 40kg K and 90kg Urea two weeks before anthesis.

Data included yield (t/ha) and disease ratings (streak and downy mildew resistance) using a rating of 1-5 where 1 = less than 10% disease infection 2 = 11 - 34%, 3 = 35 - 44%, 4 = 45 - 69% above 70% disease infection respectively, disease data were transformed using square root transformation.. Data were analysed using SAS (1993) statistical package for analysis of variance (ANOVA), while means were separated using New Duncan Multiple Range Test at P<0.05 and 0.01 for test of significance.

RESULTS AND DISCUSSION

Locations (L), variety (V), year (Y) and the V*Y interaction were significant (P<0.05) for grain yield. This suggests differences in yield performance of different varieties at various locations in both years (Table 3). L*V and L*V*Y interactions were no significant, indicating that individual location has no significant effect on the performance of individual maize genotype.

Alofe *et al.* (1993) reported that maize cultivation in Nigeria was only limited to Southern parts of the country along rainforest and derived savanna, until recently, when it was extended to northern guinea savanna where it is performing relatively better due to favorable environmental factors. This probably suggests that maize varieties that were bred for South western Nigeria ecologies were of wide adaptation. Many workers including Baker (1988), Fox *et al.* (1997), Kang and Gauch Jr. (1996), Cooper and Hammer (1996), Kempton and Fox (1977) have reported on genotype x environment interaction and its significance in crop production. Their studies however did not consider the effects of biotic and biotic stress from the environment. From this study, it was observed that the amount of rainfall as well as disease pressure significantly influenced performance of the tested varieties.

The magnitude of means squares (MS) for variety, year and location were considerably higher than rep/year, L x V and Y x L interactions. Results from this study further suggests that breeding of maize for South Western Nigerian adaptation should among other factors consider varietals yield potential, as well as seasonal variation of the year, where it is predictable. This is further corroborated by the annual total rainfall of 2002 which was significantly higher that that of 2001. Mean relative humidity was also slightly higher in 2002 except in Ibadan (Table 1). These climatic variables may have contributed to significant differences in MS values for grain yield in both years (Table 3). Since rainfall distribution of the locations within the region is bimodal (with high precipitation in April –July and September to October) in each year.

The Y*L interaction for grain yield shows differences in genotypic performance for grain yield in different years (Table 4). DMR-ESR-W and EV 8443-DMR performance for grain yield differed significantly in both years of evaluation. Mean grain yield across varieties for both years also differed significantly. In 2001, mean grain yield was 9.45t/ha *vs.* 4.4t/ha in 2002. Similarly, higher annual rainfall in 1991 among other factors might have caused the significantly lower grain yield recorded in DMR-ESR-W, DMR-LSR.W and EV 8443 DMR, which consequently affected grain yield across varieties in both years (Table 4). This implies that 1200 to 1500mm of annual rainfall may be enough for optimum yield performance of these varieties in these agro-ecological zones

Table 3 Combined means squares (MS) for grain yield across locations and years

Source of Variation	DF	Mean squares (MS)
Rep/year	6	4.76
Location (L)	5	12.31*
Variety (V)	6	14.69**
Year (Y)	1	12.23*
V x Y	6	12.0*
L x V	30	6.59
Y x L	5	12.01
V x Y x L	30	4.60
Error	36	0.197
Total	125	

Table 4. Grain yield of maize varieties in two consecutive years in South western Nigeria.

Variety	Year 2001	Year 2002
DMR-ESR-W	4.5c	4.0c
DMR-LSR-W	5.7b	3.5d
EV8443 DMR-SR	6.0a	4.5c
WY1 (check)	2.1d	2.8d
DMR-LSR-Y	5.1c	5.2c
TZBP-SR	5.4b	5.7b
TZBR	5.7b	5.3b
Mean	4.9	4.42
SE	0.23	

Values in the same column not followed by the letters are different at P<0.05

Varieties such as DMR-ESR-W and EV 8443 DMR differed significantly for grain yield in 2001 and 2002. The amount of rainfall was also significantly higher in 2002 that in 2001 thereby slightly reducing yield especially in three out of the seven maize varieties (Table 1 and 4). Similarly, Kim and Efron (1980) identified sunshine in the southern part of Nigeria as a yield-limiting factor. The importance of high yielding maize varieties had also been stressed by many workers including Darrah (1997) and Eberhart *et al.*, (1989). In Nigeria, higher maize productivity may be enhanced when disease/pests resistant, adapted and high yielding genotypes are available and fully adopted by farmers.

Table 5 presents grain yields and disease ratings across locations and years. TZBR and TZPB-SR (5.5t/ha) yielded significantly higher than others while WYI (2.45t/ha) was the lowest in terms of yield performance. Yields between 73.4 and 124.4% were recorded in the tested new maize varieties over the check entry. The superiority of these varieties over the existing ones ranked them as first in terms of yield performance (Table 5).

For disease rating, maize varieties were generally resistant to maize streak virus with low ratings of 1.0 to 2.0 except for WY1 with higher rating of 3.7. DMR-LSR-W. DMR-LSR-Y and TZPB-SR were however the best in terms of maize streak resistance. Mean streak rating across varieties and locations was 1.73 showing a reasonable degree of resistance. Downy mildew resistance scores of 1.3 to 4.8 were recorded. Varieties DMR-LSE-Y and DMR-LSR-W were the best in terms of DM resistance with ratings of less than 2.0, TZBR and TZPB-SR were susceptible to DM with ratings of 3.4 and 4.8 respectively. On the other hand, the inherent yield potential of TZPB-SR, and TZBR compensated for DM effects in these varieties. These susceptible varieties may therefore be converted to DMR for better adaptation to DM endemic belt to enhance higher yield.

Table 5: Mean grain yield and diseases ratings across locations and years.

Variety	Grain yield (t/ha)	Yield increase over check (%)	Disease ratings		Ranking based on yield
			Streak	Downy mildew	
DMR-ESR-W	4.25b	73.4	1.5b	2.3cd	5th
DMR-LSR-W	4.60b	87.7	1.0a	1.3a	4th
EV8443 DMR-SR	5.25a	114.2	1.0a	1.2a	2nd
WY1 (check)	2.45c	-	1.5b	2.1b	6th
DMR-LSR-Y	5.15a	110.2	1.3a	2.0c	3rd
TZPB-SR	5.50a	124.4	1.1a	3.4d	1st
TZBR	5.50a	124.4	2.0c	4.8e	1st
Mean	4.67		1.73	2.56	
SE	1.00			0.38	

Values in the same column not followed by the same letter are different at $P<0.05$

CONCLUSION

The improved maize varieties tested were generally suitable for south western Nigeria. They are equally fairly resistant to the prevailing diseases of the region. Varieties such as DMR-ESR-W and EV8443DMR-SR that appears to be sensitive to seasonal variations may be restricted to suitable environments.

REFERENCES

Eberhart S.A., Kim S. A. J., Mareck L. L., Darrah and M.M. Goodman 1989. A comprehensive breeding system for maize improvement in Africa In: Perrino, N.Q. and Zadan, H. (ed) Proc. Of international conference on Crop genetics Resources of Africa Vol.II IITA, IBPGR, UNEP, Ibadan Tome, Nairobi. p. 175-193.

Alofe, C.O. Adepoju A.Y. and Ogunremi, L.T. 1993. Maize agronomy in the forest zone of Nigeria. In: Fakorede M.A.B, Alofe, C.O. and Kim, S.K. (eds). Maize improvement, production and utilization in Nigeria Delar Business Center, Ile-Ife, Osun State, Nigeria pp. 97 – 104.

Ashman, B. 1991 Registration of three popcorn parental lines HP62-02 HP72-11 and HP68. Crop Science. 31:1402 – 1403

Baker R.J. 1988. Test for cross-over genotype-environment interactions. Canadian Journal of Plant Science. 68:405-410

Cooper, M. and Hammer G. (eds). Plant adaptation and crop improvement. CAB International. Wallingford, UK.

Darrah, L.L. 1986. Evaluation of population improvement in the Kenyan maize breeding method study. In. Gelaw, B. (ed) To feed ourselves. Proceedings of the first Eastern central and South Africa Regional maize workshop, CIMMYT, Mexico. pp. 160-176.

Phillip, D., Moses M and Phillip, B. 2000. Adoption of maize and related technologies in the north west zone of Nigeria. Moor Journal of Agricultural Research. 1: 89-105.

Fajemisin, J. E.; Efron Y; Kim. S.K.; Khadr E.H; Dabroski Z. T. Mareck J.H. Bajarson M; Parkinson V; Everet, L. A and Daillo A., 1985. Population and varietal development in maize for tropical Africa through resistance breeding approach. In: Brandolini, A. and Salami, F. (eds). The strategies for maize production and Improvement in the tropics. FAO, Italy. Pp. 285-408.

Fox P.N; Crossa J. and Roagosa 1977. Multi-environment testing and genotype x environment interaction. In: Kempton, R.A. and Fox P.N. Statistical methods for plant variety evaluation. Chapman and Hall. London, UK pp. 117-13

Kang M. S. and Gauch, H.G. 1996. Genotype by environment interaction: New perspective. Boca Raton CRC Press.

Kempton R. A. and Fox, P.N. 1977. Statistical methods for plant variety evaluation. Chapman Hall. London, UK.

Kim, S. K. and Efron Y. 1980. Stem-borer Resistance Breeding IITA Report pp. 84-87.

Olakojo S.A. and Iken, J. E. 1999. Productivity of maize genotypes in downy mildew endemic one of south western Nigeria, Nigeria Journal of Genetics 14:64-68.

Olakojo, S.A. and Iken, J. E. 2001. Yield performance and stability of some improved maize (*Zea mays* L) varieties. Moor Journal Agricultural Research. 2:21-24.

Olakojo S.A. , Kogbe J.O.S, Olajide V. and Dohniell A. 2001 Host-parasite relationship of *Striga asiatica* and maize (*Zea may*s) under varied moisture levels and Nitrogen sources. Nigerian Journal Weed Science. 14:41-46

SAS 1993, SAS user's guide version 6, 2nd edition Ins. Inc. Cary. NC. 27513.

Shumba E.M. 1986. Selecting food crop for security. Diffusion (9):7-14

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