Tropical Agricultural Research and Extension 4(2) : 2001

Evaluation of downy mildew resistant maize (*Zea mays* L) varieties in the disease endemic status of south western Nigeria

S.A. Olakojo [1*], J.E. Iken[1] and J.M. Fajemisin[2]
[1]Institiute of Agricultural Research and Training, Obafemi Awolowo University, PMB 5029, Moor Plantation, Ibadan, Nigeria. E-mail: dart@infoweb.abs.net
[2]International Institute for Tropical Agriculture, Ibadan, Nigeria

Accepted 22nd August 2001

ABSTRACT

On-farm evaluation of downy mildew resistant (DMR) maize varieties was carried out in 32 locations of downy mildew (DM) endemic areas of South-western Nigeria covering Ogun, Osun, and Oyo states, for two years. Mean grain yield of improved DMR varieties varied between 2222 to 3578 kg ha^{-1} as against 1022 to 18822 kg ha^{-1} in downy mildew susceptible (DMS) varieties. In general DMR maize varieties significantly outyielded the DMS varieties by about 200% while the G x E interactions showed that varieties, and yield x variety were highly significant for yield. DM severity rating varied between 1.56 to 1.64 in the DMR materials compared with 4.51 and 4.7 in the DMR varieties. In fact, cultivars 'Ibadan local' and 'western yellow' exhibited total susceptibility to DM pathogen in almost all states. DMR varieties were also seen to have responded differently to varied agro-ecologies as well as varied seasons of the year. The advantages of the use of DMR varieties in these agro-ecologies are discussed.

Key words : Disease resistance, downy mildew, maize, multilocational testing

INTRODUCTION

Maize (*Zea mays* L.) is increasingly becoming important not only in Nigeria but also in other developing countries of the world, with a total hectarage of about 58.5 million ha in 1990 (CYMMIT 1992). It has also formed the major raw material in many agro-allied industries (Oyekan *et al.* 1990). Although, several other biological constraints are reported to affect maize production in Nigeria, downy mildew has been identified as the most important disease of maize. Downy mildew disease of maize which is caused by *Peronosclerospora sorghi* (Weston) (Anaso *et al.*1987) is seriously threatening maize production not only in Nigeria but also in other countries of the world such as Philippines, India, Zambia and Mozambique (Frederiksen and Renfro 1970).

The causal pathogen was first reported by King (1970) in Samaru, the extensive occurrence was later reported in Owo by Fajemisin (1980a) where 60% of yield loss was attributed to this devastating disease. Oyekan *et al.* (1989) also estimated a yield loss of about 60% to DM in Kwara state. The disease has been attributed to 50 and 100% yield losses as the plants are infected at anthesis and seedling stages especially 2-3 weeks after planting (Annual Report. IITA. 1986).

* Corresponding author

Yields have been observed to be dependent on many factors mostly level of DM infection, soil fertility, genetic potential of the variety as well as enviromental conditions (Kim *et al.* 1990). Downy mildew resistance breeding initiated in Nigeria by Fajemisin (1970) has been subsequently consolidated by national and international research efforts. Such efforts were described by Kim (1989) where resistance level in maize had been increased up to 70-95% resulting in approximately *300%* yield increase over the susceptible varieties in researcher-managed plots.

Earlier Okigbo (1976) ascribed 60% of maize produced in Nigeria to high rainforest belt, while Kassam *et al.* (1975) emphasised that highest potential for maize production was in the Guinea savanna of Nigeria. Unfortunately these two maize producing belts have been found to be endemic to DM by several diagnostic surveys (Obajimi and Adenle1996).

The released DMR maize varieties, which have been tested largely on-station are yet to be evaluated on-farm under farmers environments and management conditions. Our objectives therefore were: (1) to evaluate the DMR varieties on-farm for yield and DMR in multilocational trials; (2) demonstrate the high yield potentials of the improved varieties under farmers fields and; (3) to acquaint farmers in different farming communities with the option of using DMR varieties to obtain

higher yields.

MATERIALS AND METHODS

Four DMR maize varieties (DMR-ESR-W. DMR-ESR-Y. DMR-L.SR-Y and DMR-LSR-W) and two check entries ('Western yellow'- a popular maize variety and 'Ibadan local'. - an elite maize cultivars) were used in the evaluation. Thirty- two locations in the DM endemic areas of South-western Nigeria covering Ogun, Oyo, Ondo and Osun states were selected for the trial. Data from eight locations from individual state were pooled to represent one replicate.

Each entry was planted to a four row- plot of 10 × 5 m between May and June of 1997 and 1998, when DM disease pressure was high in the test sites. Plant spacing was 75 × 25 cm with two seeds per hill, which were later thinned to one, three weeks after planting. N.P.K 20-10-10 fertilizer was applied at 200 kg ha^{-1} immediately after thinning, while other common cultural practices such as weeding and protection from vertebrate pests were strictly and promptly adhered to. Each varietal entry was replicated three times and arranged in a randomised complete block design .Fungicides were not used in the experiments for better occurrence of the disease and assessment of the varieties for DMR.

Agronomic data recorded from the two middle rows of each plot included: plant and ear heights (cm), plant and ear aspects using ratings (1-5) where 1 = excellent, 2 = very good, 3 = good, 4 = fair, 5 = poor; shelling%; moisture% at harvest; as well as yield kg ha^{-1}. Downy mildew severity ratings were also scored under natural infestation using scale 1-5, where 1=less than 10% infection, 2 = 11-40%, 3 = 41-60%, 4 = 61- 75%, 5= 76-100% downy mildew infection.

Agronomic and disease ratings were pooled and statistically analyzed using analysis of variance (ANOVA). The G X E interactions were also computed for yield and downy mildew score

RESULTS

The evaluation of the DMR maize varieties, days to maturity, grain texture as well as endosperm colour are described in Table 1. Agronomic characters such as plant and ear heights, which were significantly different, recorded means of 177.5 and 102.2cm, respectively, indicating the diverse nature of their genetic make-up. Shelling% was significantly different with a mean of 85.6%, while plant and ear aspects, were not significant, but, recorded means of 2.17 and 2.50 respectively (Table 1) suggesting how

Table 1. Agronomic characters of the varieties of maize evaluated in 1997 and 1998

Variety	plant height	Ear height	Maturity	Grin texture	Endosperm colour	Shelling %
DMR-ESR-W	151	80	80-90	dent	white	88
DMR-ESR-Y	147	175	90-95	dent	yellow	86
DMR-LSR-W	175	100	105-115	dent	white	84
DMR-LSR-Y	177	103	105-120	dent/flint	yellow	89
Western Yellow	206	119	120-130	dent	yellow	85
Ibadan Local	209	129	120-130	dent	yellow	82
Mean	177	102	-	-	-	85
C.V%	13.5	17.4	-	-	-	2.75
LSD	7.2*	6.2*	-	-	-	2.3*

desirable the agronomic traits of the varieties were.

Mean grain yield varied between 2267 and 3356 kg ha^{-1} in the (DMR) maize varieties in Ogun in 1997 as against the range of between 2533 and 3067 kg ha^{-1} in 1998 (Table 2). However low yields range of 1022 and 1778kg ha^{-1} were recorded in this state for (DMS) check varieties. The yield trend followed the same pattern in other three states (Ondo. Osun and Oyo) with DMR varieties significantly showing superiority over (DMS) check varieties with 200% yield increase (Table 3). Although, mean yield across genotypes was significant, grain yield across locations appeared stable and non-significant. Mean grain yield in each location in both years was also significantly different, showing yield responses of these varieties to environmental variations.

Table 2. Analysis of variance for yield of the tested maize varieties in the disease endemic status of South-western Nigeria.

Source of variance	DF	MS	F
Location (L)	3	833,363.43	1.33NS
Year (Y)	1	118,680.42	1.0NS
L X Y	3	750,230.64	2.99NS
Variety	5	14,822,747.3	477.75**
V X L	15	35,997.13	1.16NS
V X Y	5	200,926.58	6.48*
V X LY	15	30,888.69	1.0NS
Error	80	31,025.96	

P = 0.05

Table 3. Mean grain yield (kg ha^{-1}) of the maize varieties evaluated in the DM endemic status of S.W Nigeria in 1997 and 1998

Variety	Ogun		Ondo		Osun		Oya		Mean	
	1997	1998	1997	1998	1997	1998	1997	1998	1997	1998
DMR-ESR-W	2267	2533	2444	2466	2467	2800	2222	2822	2350	2655
DMR-ESR-Y	2422	2533	2511	2422	2667	2844	2333	2911	2483	2678
DMR-LSR-Y	3111	3067	3566	3133	3178	3578	2956	3407	3200	3311
Western Yellow	1778	1400	1822	1622	1844	1978	1711	2134	1787	1764
Ibadan Local	1378	1022	1467	1156	1400	1311	1289	1244	1384	1183
Mean	2385	2252	2252	2330	2463	2645	2645	2248	-	-
CV%	7.63	9.39	5.59	8.02	7.71	8.62	5.67	4.74	-	-
LSD	38.8*	40.9*	13.9*	13.6*	37.9*	13.9*	12.4*	13.8*		

The G X E interactions revealed that location, year, and location x year as well as variety x year interactions were not significantly different for seed yield. However varieties and their interactions with year were highly significant (Table 2), suggesting that cultivation of DMR varieties should be encouraged especially when climatic conditions are

Table 4. Means of DMR rating, plant aspects and ear aspects across locations in 1997 and 1998 of maize evaluated in South-western Nigeria

Variety	DMR ± SE	Plant aspect ± SE	Ear aspect ± SE
DMR-ESR-W	1.56 ± 0.20	1.42 ± 0.20	2.20 ± 0.40
DMR-ESR-Y	1.57 ± 0.23	1.02 ± 0.10	2.31 ± 0.10
DMR-LSR-W	1.56 ± 0.24	1.28 ± 0.13	1.69 ± 0.20
DMR-LSR-Y	1.64 ± 0.33	1.29 ± 0.20	1.8 ± 0.40
Western yellow	4.51 ± 0.33	3.24 ± 0.12	3.21 ± 0.30
Ibadan local	4.7 ± 0.27	4.61 ± 0.20	3.8 ± 0.20

favourable to causal pathogen of DM, so as to reduce its severity and subsequently enhance higher grain yields.

The DM score were not significantly different across locations and year, but varied between 2.4 and 2.8, but were significantly different between genotypes in both years and in all locations (Table 2) .The DMR varieties recorded low rating of between 1.56 and1.64, while two susceptible check entries showed low levels of tolerance to DM with ratings of between 4.51 (Western yellow) and 4.7 (Ibadan local) across locations in both years. Indicating high susceptibility of the two varieties to DM in the trial locations (Table 4).

DISCUSSION

Incidence of downy mildew disease resulting in low yields of the indigenous cultivars is a major production constraint in Nigeria. In fact 100% yield losses have been reported by Kim *et* a/ (1990). It is therefore important that farmers take advantage of these high yielding (2.5- 3 t ha^{-1}) varieties for enhanced higher yield/ha and to reduce the incidence of DM disease in the region. Use of the DMR varieties is presently the cheapest, most effective and easily affordable means of controlling downy mildew. The use of DMR seed has also been reported to have reduced the incidence of DM by about 80% in Ondo and Ekiti states in 1998 (Aladesaye personal communication). Exchange of DMR varieties among the farming community of the university of Ilorin in addition to dressing of seed with fungicides has also been observed to be responsible for low level (1%) of DM incidence in the area (Olaoye 1998 personal communication).

Although, use of fungicides had been equally effective in the control of downy mildew disease, the high cost of this fungicide and the effect of its accumulation in the environment have not been strictly addressed. The use of DMR varieties thus became relevant, if not highly imperative.

ACKNOWLEDGEMENT

The authors are grateful to Mr G.O. Oladapo for the statistical analysis of the data.

REFERENCES

Anaso AB, Taygi PD, Emecebe AM and Manzo SX 1987 Identity of downy mildew on maize in Nigeria Guinea savanna: Samaru J. Agric. Res. 5(1 &2):13-23. CYMM1T(1992)

Fajemisin JM, Efron Y, Kirn SK, Khadr FH, Dabrowski ZT, Mareck J, Bjarnason M, Parkinson V, Evertt LA and Diallo A 1985 Population and varital development in maize for tropical Africa through resistance breeding in breeding strategies for maize production and improvement in the tropics. Brandolina A andSalamini F eds F.A.O AND inst Agro L'OLTREMARE, Italy.

Fajemisin JM 1980a Downy mildew of maize in Nigeria 120-134. In: Inter. Confer. on the Graminacious downy mildew disease Beltgio, Italy 1979, Rokefelter foundation. NY, USA.

Frederiksen RA and Renfro BI 1977 Global status of downy mildew of maize. Annual review of Phyto. path. 15:249-275

Kassam AH, Kawal M, Dagg and Harrison MN 1975 Maize in West Africa and its potential in savanna areas world crop 27 :(March- April) 1975. pp. 73-78

IITA (1986) Annual report and Research highlight of International Institute of Tropical Agriculture, Ibadan. pp. 63-64

Kim SK, Mareck JH, Iken J, Obajimi OA, Olanya OM, Oyekan PO and Kling J 1990 Control of downy mildew of maize through the development of resistant varieties: proceeding of the workshop on DM disease of maize held on Aug 1990 at college of Agric. Akure. pp. 19-23

King SB 1970 Cereal pathology. Seventh Annual Report AID-STRC OP. pp. 68-81

Obajimi OA and Adente V (1996). Survey of thel Incidence, distribution and control of Downy mildew of maize in South Western Nigeria. In: The 1998 reports of the in-house review of Institute of Agricultural Research and Training Ibadan (IAR&T) Ibadan. pp. 39-42

Okigbo BE 1976 Cropping system and rotations of maize production course, Moor Plantation Ibadan May-Aug 1976.

Oyekan PO, Olanya OM, Obajimi OA, Iken J, Weber GK, Mareck JH and Kim KS 1989 Downy mildew on maize in Nigeria. Distribution, virulence and recommendations, IAR&T and IITA, Ibadan, Nigeria. p. 22

Oyekan PO, Olanya OM, Adenle V and Weber GK 1990 Downy mildew of maize in Nigeria: Epidemilogy, distribution and importance. Proc. Workshop on Downy mildew August 1990, College of Agric., Akure, Nigeria. pp. 14-18