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Evaluation of rice breeding lines for combined effect of African rice gall midge and iron toxicity in Nigeria

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ABSTRACT: Thirteen fixed lines from the cross of FARO 12 and 44 were evaluated at Edozhigi and Gara villages, located in central Nigeria. The trial was conducted to select promising lines to be used for African rice gall midge (AfRGM) and iron toxicity endemic areas. The experiment was randomized complete block design replicated three times. The result showed significant differences in grain yield at Gara but not at Edozhigi. Percentage tiller damage for AfRGM was high in both locations. Iron toxicity score was also moderate for the two locations, however higher scores were obtained at Edozhigi. FAROX 510-B-115-2-2 was better for iron Gara while FAROX510-B-1-1 and FAROX510-B-5-5-4-1-2 were better at Edozhigi. Lines with grain yield above 2tons/ha can be recommended for AfRGM/iron toxicity endemic rice growing ecologies of Nigeria.

Key words: African rice gall midge, iron toxicity, resistance, rice and grain yield.

Introduction

Rice yields could be threatened by both biotic and abiotic stresses. Pests and diseases contribute immensely to yield reduction in rice fields. The major pests of rice include blast, brown spot, stem borer and AfRGM. Toxicity to iron and aluminium, drought and flood can be serious abiotic problems to farmers (Singh et al., 1997). AfRGM and iron toxicity have been identified to be serious problem especially in the rainfed lowland rice fields of Nigeria (Singh et al., 1997).

African rice gall midge, *Orseolia oryzivora* Harris and Gagne is an insect pest indigenous to Africa (Williams et al., 2002). It is widely distributed south of Sahara, particularly in West Africa but has not been found outside the continent (Williams et al., 2002). Serious losses were reported from southern Burkina Faso in the late 1970s and extensive outbreaks occurred in South-eastern Nigeria in 1988 which causes about 80% yield losses from farmers fileds (Ukwungwu et al., 1989; Williams et al., 2002). The AfRGM is a pest of lowland rice but upland rice fields are occasionally attacked (Singh et al., 1997, Williams 2002).

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The pest does not kill the plant but infested tiller cannot produce grain (Gana et al., 1999, Williams et al., 2002). Although rice varieties normally compensate for lost tillers by producing extra tillers (NCRI, 1998; Williams et al., 2002), many a times such tillers are formed too late to contribute to grain yield. The level of infestation varies from one rice variety to another (Williams, 1996). In general, the amount of yield loss varies with the growth stage of the crop when it is infested. This is probably because growth stage determines the plants ability to compensate for midge damage by producing extra tillers that can bear panicles if not further affected (Williams et al., 2002).

Iron toxicity also known, as bronzing is a nutritional disorder of lowland rice associated with excess water-soluble iron. It appears on various soil types especially on acid sulfate soils (Ponnomperuma et al., 1973; Beye et al., 1975). A high percentage of spikelet sterility occurs in highly susceptible cultivars. Virmani, (1979) reported that the intensity of symptoms monitored on four rice cultivars at Suakoko varies with the rice varieties. He observed that the rate of development of toxicity symptoms depended upon the level of tolerance of a cultivar. Various methods have been proposed to reduce iron concentration in the soil, which include, drainage of the field, application of balanced nutrient and ridge planting (Singh et al., 1997). However the use of resistant varieties is often advocated (Virmani 1979, Singh et al., 1997).

This study was therefore carried out to identify varieties that will produce stable and high grain yield when grown under AfRGM and iron toxicity problem areas.

Materials and Methods

Thirteen fixed lines and four checks were evaluated at two locations. Edozhigi and Gara (Central Nigeria). The four checks are TOS 14519 (AfRGM tolerant), FARO 52 (AfRGM susceptible); Suakoko 8 (iron toxicity tolerant) and TOX 3069-66-1-6-6 (iron toxicity susceptible). The experiment was conducted in 2003 in a natural field condition using a ramdomized complete block design with three replications. The plot size was $10m^2$ with plant spacing of 20x20 cm. Each plot was supplied with N_2, P_2O_5 and K_2Obroadcast at the rate of 60-30-30kg/ha respectively. Data collected include days to 50%flowering, plant height and number of panicles/m^2. AfRGM scores were taken at 43 and 63 days after transplanting (DAT) by counting the percentage tiller damage on 10 hills stage is reasonably closely related to yield loss (Williams et al., 2002). High levels of infestation were recorded in this study, this could explain relatively low yield recorded.

This result demonstrates high level of midge infestation in these locations and the risk levels the rice farmers in these areas are facing. Williams et al., (2002 stated that at infestation levels from 0% to about 30%, an increase of 1% in the percentage of tiller damage could reduce yield to about 2 to 3%. It has been identified that 60% of the lowland rice grown in West and Central Africa may be at risk from iron toxicity also (WARDA, 2001-2002). Average yield loss due to iron toxicity amounts to 50%, and could range from 10 to 100%. This suggests a serious production constraint to farmers.

Results and Discussion

Results from Edozhigi (Table 1) showed significant differences in all the parameters except number of panicle /m^2 and grain yield. Most entries showed highly susceptible reaction to gall midge (over 25% tiller damage) at 43 DAT. At 63 DAT the infestation level was lowered, with most entries scoring at susceptible level (11-25% tiller damage). TOS 14519 was the best at both dates with less than 2% tiller damage. Iron toxicity score ranged from 4-8 at 40 and 60 DAT. SUAKOKO 8, the iron toxicity tolerant check scored 5 and 4 at 40 and 60 DAT respectively. Two other entries had the same level of resistance to iron toxicity. These are FAROX510-B-11-1-1 and FAROX510-5-4-1-2. Plants exhibited tall heights with TOS 14519 showing the tallest height (208cm). FAROX510-B-6-3-1-3 matured earlier than other entries (106 days to 50% flowering). Results from Gara (Table 2) showed significant differences in all parameters measured except panicle number/m^2 and iron toxicity score at 40 and 60 DAT. TOS 14519 was the best entry for AfRGM at 42 DAT (6.8%) and 63 DAT (1.85%). FAROX510-B-1-1-2 was the most damaged by AfRGM, 61.03% and 46.21% for both dates respectively. Iron effect ranged from 2-5 with non-significant difference among entries. FAROX510-B-15-4-2-1 gave the best grain yield record (2500 kg/ha). Six other entries exceeded 2tons/haincluding FARO 52 a high yielding released variety in iron toxic ecology of Nigeria.

Table 1: Grain yield and other agronomic traits for AfRGM/iron toxicity at Edozhigi.

Entries	**Days to 50%**	**Pl. ht.**	**Pan.**	**AfRGM**		**Iron**		**Grain yield**
	flow	**(cm)**	**No/m^2**	**43 DAT**	**63 DAT**	**40 DAT**	**60 DAT**	**Kg/ha**
FAROX510-B-4-1-3	123	149	275	25.3	17.9	6	5	1389
FAROX510-B-3-1-2-2	111	158	333	21.97	12.48	6	5	1041
FAROX510-B-15-4-2-1	120	138	347	25.93	22.17	6	6	941
FAROX510-B-11-1-1	119	176	250	23.83	14.63	4	4	1302
FAROX510-B-10-2-1-2	124	132	348	26.6	18.13	6	8	895
FAROX510-B-15-2-2	126	141	310	21.03	15.13	6	7	1242
FARO510-B-13-B-1-1-2	126	141	317	26.17	17.47	6	6	806
FAROX510-B-B-B-9-2	122	133	327	29.13	16.97	6	6	1250
FAROX510-B-1-1-1	125	138	306	26.67	17.68	6	6	1134
FAROX510-B-6-3-1-3	106	137	318	24.13	14.13	4	6	942
FAROX510-B-1-3-1-1	110	140	360	22.27	16.83	4	6	1678
FAROX510-B-5-5-3-4	122	143	312	29.77	14.27	5	6	1303
FAROX510-B-5-4-1-2	112	176	347	21.87	10.17	4	4	1365
SUAKOKO 8	120	183	387	15.6	9.2	5	4	926
TOS 14519	113	295	345	1.67	1.4	5	5	1659
TOX 3069-66-1-1-6-6	118	137	333	30.93	14.1	6	6	1319
FARO 52	121	154	313	36.30	14.07	5	6	872
LSD at 5%	5.47	9.84	NS	8.58	4.83	1.12	1.4	NS
CV(%)	3.91	5.49	13.17	30.26	28.13	17.87	21.94	36.91

Percent tiller infestation is commonly used as a measure of the level of midge infestation on the rice crop. Observations under rainfed lowland conditions in Nigeria have shown that percent tiller infestation recorded when rice plants are at stem elongation growth per plot. Iron toxicity scores were taken at 40 and 60 DAT using standard evaluation system for rice (IRRI, 1996).

Conclusion

The result explains high yield reduction that could be experienced by farmers in AfRGM/iron toxicity infested area. TOS 14519 was the best variety for the two locations for AfRGM resistance and could be exploited for genetic improvement for AfRGM resistance. However, it was not the best yielder at both Edozhigi and Gara. Looking at the two results, varieties with more than 2tons at Gara and more than 1.5 tons at Edozhigi could be further evaluated to be introduced in locations affected by a combination of AfRGM and iron toxicity.

Table 2: Grain yield and other agronomic traits for AfRGM/iron toxicity at Gara.

Entries	Pl ht.	Pan.	AfRGM		Iron		Grain yield
	(cm)	No/m^2	43DAT	63DAT	40DAT	60DAT	Kg/ha
FAROX510-B-4-1-3	82	152	46.37	33.27	4	4	1542
FAROX510-B-3-1-2-2	87	160	13.42	9.50	4	4	1883
FAROX510-B-15-4-2-1	82	160	28.08	32.56	4	4	2500
FAROX510-B-11-1-1	106	158	25.47	28.95	4	4	1909
FAROX510-B-10-2-1-2	72	155	37.74	20.12	5	4	1697
FAROX510-B-15-2-2	79	158	23.61	19.37	4	3	2115
FAROX510-B-13-1-1-2	84	143	61.03	46.21	4	3	2160
FAROX510-B-B-B-9-2	82	168	52.67	42.14	4	3	2102
FAROX510-B-1-1-1	85	182	10.79	31.17	3	3	2449
FAROX510-B-6-3-1-3	74	160	18.11	29.09	3	4	1523
FAROX510-B-1-3-1-1	78	187	22.30	44.75	2	5	1523
FAROX510-B-5-5-3-4	84	155	24.11	35.15	3	4	2202
FAROX510-B-5-4-1-2	78	162	23.04	12.75	4	4	1732
TOS 14519	123	177	6.87	1.85	4	4	1801
TOX 3069-66-1-1-6-6	78	188	11.74	39.53	5	3	1782
FARO 52	94	167	36.44	36.17	4	3	2403
LSD at 5%	6.4	NS	19.7	17.66	NS	NS	318
CV (%)	6.27	13.07	60.80	51.84	33.26	25.74	13.76

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