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Resistance Status of Upland NERICA Rice Varieties to Termite Damage in Northcentral Nigeria

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Abstract: Upland rice is mostly at risk from soil insect pests, including termites which cause significant yield losses. Studies were conducted at Kasua-Mangani, Kaduna State, Northcentral Nigeria, to evaluate the resistance status of 18 upland NERICA rice varieties to termite attack. The percent plant attacked by termites on the 18 NERICA varieties at 60 and 90 Days after Sowing (DAS) was between 2.47 to 12.45% and 3.82 to 20.89%, respectively. There was no significant difference in the response of NERICA rice varieties to termite attack at 60 and 90 DAS. The resistance status of NERICA rice varieties to termite attack was classified into 4 groups as follows: Moderately Resistant (MR), Moderately Susceptible with recessive resistance (MSr), Moderately Susceptible (MS) and Highly Susceptible (HS) according to cluster analysis. Of the 18 NERICA rice varieties studied, only NERICA 5, 14 and 18 were classified as MR and could be recommended as the most adapted rice varieties in termite prone areas of Northcentral Nigeria.

Key words: Upland NERICA rice varieties, termites, biotypes, percent plant attacked, resistance, Northcentral Nigeria

INTRODUCTION

Termites are an important component of tropical and sub-tropical ecosystems. They are considered to be the most significant soil insect pests of crops in Africa (Wood and Cowie, 1988) and attack a wide range of crops at all stages of the growth cycle (Mitchell, 2002). Although, they are problem in upland rice, infestations can also be severe in light-textured low moisture content soils in rainfed wetland areas. Termites attack living rice plants when dead plant material is not available and generally late in the crop growth stage (Pathak and Khan, 1994). They attack drought-stressed crops and prefer older plants having greater cellulose content. They tunnel through the plant stem and eat the roots. The attacked plants become stunted and then wilt. Termite attack also predisposes plants to further damage by ground-dwelling pests such as rodents, ants, saprophytic fungi and bacteria (Wood and Cowie, 1988). Yield losses due to termite damage ranging from 50 to 100% have been reported by Sekamatte *et al.* (2001) and Rao *et al.* (2000).

Broad-spectrum and organochlorine insecticides have been largely relied upon for the control of termites (UNEP, 2000). The limitations associated with the application and efficacy of these chemicals such as the destruction of non-target insects, high cost of the chemical insecticides, accidental poisoning accidents and environmental pollution emphasizes the need for alternative methods (Tom, 1991; Pearce *et al.*, 1995; Rao *et al.*, 2000). Other non-chemical control measures such as biological control, cultural control, the use of plant extracts and host plant resistance are being relied upon to control termite infestation (Sekamatte *et al.*, 2001; Pearce *et al.*, 1995; Nwilene *et al.*, 2008). Because of the unique advantages of host plant resistance, it is believe to be a durable strategy in the integrated control of rice insect pests in developing countries. The use of host plant resistance is a major objective in rice-based programs in developing countries because the income per hectare in rice production is relatively low and money spent on control measures such as chemical insecticides significantly reduces profits.

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The New Rice for Africa (NERICA) is a new variety of rice developed by the Africa Rice Center (WARDA) from a cross between the local African rice *Oryza glabberima* and the Asian type *Oryza sativa*. It is becoming increasingly popular amongst farmers for its early maturity, drought and pest resistance. Seven NERICA varieties, which were popular among farmers were named in 2000 by WARDA. In 2005, eleven more NERICA varieties were named by the Africa Rice Center (WARDA) Variety Nomination Committee, based on their excellent performance and popularity among farmers bringing the total number of upland NERICA varieties characterized and named by the Center to eighteen. All these 18 NERICA varieties are suitable for the upland rice ecology of sub-Saharan Africa. To date, there is no available information on the reaction of these 18 released upland NERICA rice varieties to termite damage. In the present study, resistance status of eighteen upland NERICA rice varieties to termite damage was evaluated under natural infestation in Northern Nigeria.

MATERIALS AND METHODS

The study site: The study was conducted between April to October in 2006 at Kasua-Mangani, Kaduna State, Northcentral Nigeria. Kaduna lies between latitude 09°30′N and longitude 08°30′E in the Northern Guinea Savannah zone. The climate of Kaduna is tropical with a distinct rainy season (late April- October) and dry season (October-May) (Emere and Nasiru, 2007). Generally, the soils and vegetation are typical red-brown to red-yellow tropical ferruginous soils and savannah grassland with scattered trees and woody shrubs. The soils in the upland areas are rich in red clay and sand but poor in organic matter.

Experimental design: The experimental design for the study was Randomized Complete Block Design (RCBD) with three replications. Eighteen upland NERICA rice varieties (Table 1) were screened for tolerance/resistance to termites damage. LAC23 was included as a resistant check while IDSA6 was included as a susceptible check (Table 1). The rice seeds were directly sown at a spacing of 20 cm by 20 cm. The plot size was 2 m by 5 m. The distance between plots was 0.50 m. There were two rice seedlings per hill. Gap filling was done 7 Days after Sowing (DAS). All treatments including control received basal fertilizer application at the rate of 30 kg N, 30 kg P_2O_5 and 30 kg K_2O ha^{-1} and a top dressing 25 DAS at the rate of 15 kg N ha^{-1} Weeding was done at 21 and 42 DAS and subsequently as when due. The number of plants attacked by termites was recorded at 60 and 90 DAS. Termite damage was scored by visual observation of plants that lodged due to attack. A new evaluation scale similar to that used for the African rice gall midge and stemborers was used to measure resistance/tolerance to termites damage (Table 2). Scores between 0 and 3 indicate that the test entries are equal to or similar to the resistant check and thus favorable. Scores between 7 and 9 means equal to or similar to the susceptible check and that the genetic potential of the test entry is unfavorable for exploitation in rice improvement programs while a score of 5 means intermediate between the first two mentioned above and that the test entry may be acceptable under some circumstances.

Table 1: List of 20 rice varieties screened under natural infestation at Kasua-Mangani, Kaduna State, Northcentral Nigeria during 2006 wet season

Variety No.	Variety	Code name
V1	NERICA 1	WAB 450-IBP-38-HB
V2	NERICA 2	WAB 450-1-1-P31-1-HB
V3	NERICA 3	WAB 450-IBP-28-HB
V4	NERICA 4	WAB 450-IBP-91-HB
V5	NERICA 5	WAB 450-11-1-1-P24-HB
V6	NERICA 6	WAB 450-IBP-160-HB
V7	NERICA 7	WAB 450-IBP-20-HB
V8	NERICA 8	WAB 450-1-BL1-136-HB
V9	NERICA 9	WAB 450-BL1-136-HB
V10	NERICA 10	WAB 450-11-1-1-P41-HB
V11	NERICA 11	WAB 450-16-2-BL2-DV1
V12	NERICA 12	WAB 880-1-38-20-17-P1-HB
V13	NERICA 13	WAB 880-1-38-20-28-P1-HB
V14	NERICA 14	WAB 880-1-32-1-2-P1-HB
V15	NERICA 15	WAB 881-10-37-18-3-P1-HB
V16	NERICA 16	WAB 881-10-37-18-9-P1-HB
V17	NERICA 17	WAB 881-10-37-18-13-P1-HB
V18	NERICA 18	WAB 881-10-37-18-12-P3-HB
V19	LAC 23	Resistance Check (RCK)
V20	IDSA 6	Susceptible Check (SCK)

Table 2: Field evaluation scale for resistance/tolerance to termite damage on rice

Score	Pant attacked (%)	Evaluation description
0	No damage	Highly resistant
1	Less than 1	Resistant
3	1-5	Moderately resistant
5	6-10	Moderately susceptible
7	11-25	Susceptible
9	More than 25	Highly susceptible

Data analysis: The percent plant attacked at 60 and 90 DAS, the analysis of variance (ANOVA), mean comparison and Unweighted Pair Group Method Arithmetic Mean (UPGMA) principal component cluster analysis were carried out on the raw data using SAS statistical software (SAS Institute, 2002-2003).

RESULTS

Resistance status of 18 upland NERICA rice varieties to termite damage in Northcentral Nigeria was evaluated. The percent plant attacked by termite on the 18 NERICA rice varieties at 60 and 90 Days after Sowing (DAS) was between 2.47 to 12.45% and 3.82 to 20.89%, respectively (Table 3). According to ANOVA results, there was significant difference in percent plant attacked by termites at 60 and 90 DAS, indicating that termite attack was severe at 90 DAS than at 60 DAS (Table 4). However, there was no significant difference among the NERICA rice varieties to termite attack at 60 and 90 DAS, indicating that the response of NERICA to termite attack was the same at both 60 and 90 DAS (Table 4). The resistance status of the 18 NERICA rice varieties and 2 checks to termite damage has been revealed by this study (Fig. 1, 2). According to cluster dendrogram, the classification of the levels of resistance of the 20 rice varieties to termite damage are as follows: NERICA5, NERICA14, NERICA18 and LAC23 were classified as moderately resistant (MR); NERICA1,NERICA8,NERICA10,NERICA12,NERICA13, NERICA15 and NERICA17 were classified as moderately susceptible with recessive resistance (Msr); NERICA2, NERICA3, NERICA4, NERICA6, NERICA7, NERICA9 and NERICA11 were classified as moderately

Table 3: Termite damage on 20 rice varieties at 60 and 90 days after sowing at Kasua-Mangani, Kaduna State, Northcentral Nigeria during 2006 wet season

	Plant attacked (%)		
Variety	60 DAS	90 DAS	Mean % plant attacked
NERICA 1	3.43e	5.58cde	4.51
NERICA 2	8.39bcde	14.68bcd	11.54
NERICA 3	10.43bcd	20.89ab	15.67
NERICA 4	5.27cde	13.43abcd	9.35
NERICA 5	4.29de	3.89cde	4.09
NERICA 6	12.45b	9.51bcde	10.98
NERICA 7	9.14bcd	17.19abc	8.19
NERICA 8	6.76bcde	8.79bcde	7.77
NERICA 9	11.14bc	8.44bcde	9.79
NERICA 10	5.68cde	5.54cde	5.61
NERICA 11	9.00bcde	14.64abcd	11.82
NERICA 12	6.19bcde	9.05bcde	7.62
NERICA 13	4.97de	7.49bcde	6.09
NERICA 14	2.47e	3.82de	3.15
NERICA 15	5.49cde	8.48bcde	6.98
NERICA 16	2.50e	7.69bcde	5.10
NERICA 17	6.82bcde	9.55bcde	8.19
NERICA 18	6.13bcde	3.80de	5.31
LAC 23	3.13e	1.14e	2.14
IDSA 6	33.64a	34.69a	34.17

*Means within a column followed by the same letter(s) are significantly different at $p<0.05$. Tukey's studentized range test. DAS = Day After Sowing

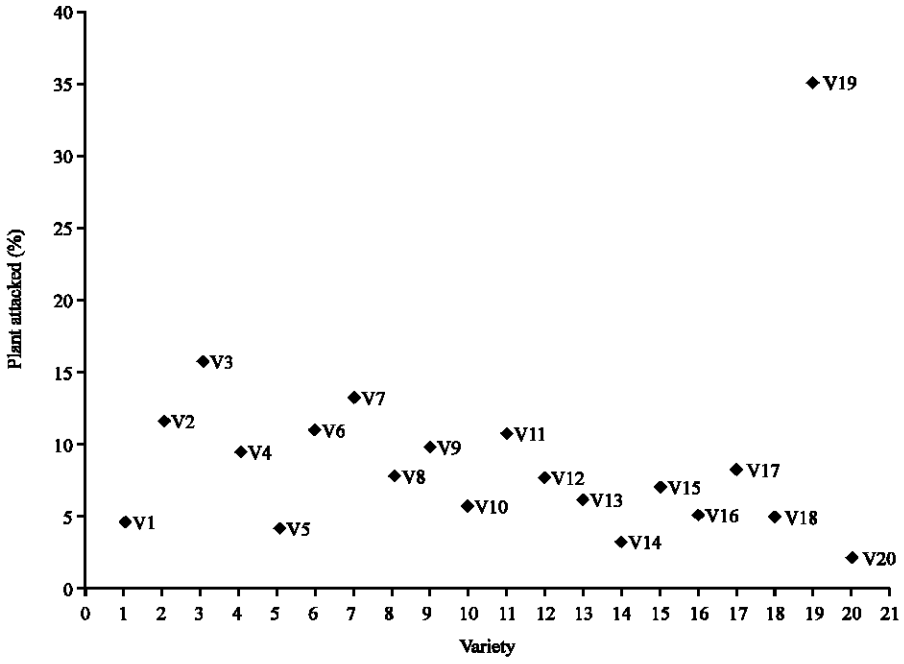

Fig. 1: The resistance status of 20 rice varieties to termite damage. 1: NERICA 1; 2: NERICA 2; 3: NERICA 3; 4: NERICA 4; 5: NERICA 5; 6: NERICA 6; 7: NERICA 7; 8: NERICA 8; 9: NERICA 9; 10: NERICA 10; 11: NERICA 11; 12: NERICA 12; 13: NERICA 13; 14: NERICA 14; 15: NERICA 15; 16: NERICA 16; 17: NERICA 17; 18: NERICA 18; 19: LAC 23; 20: IDSA 6

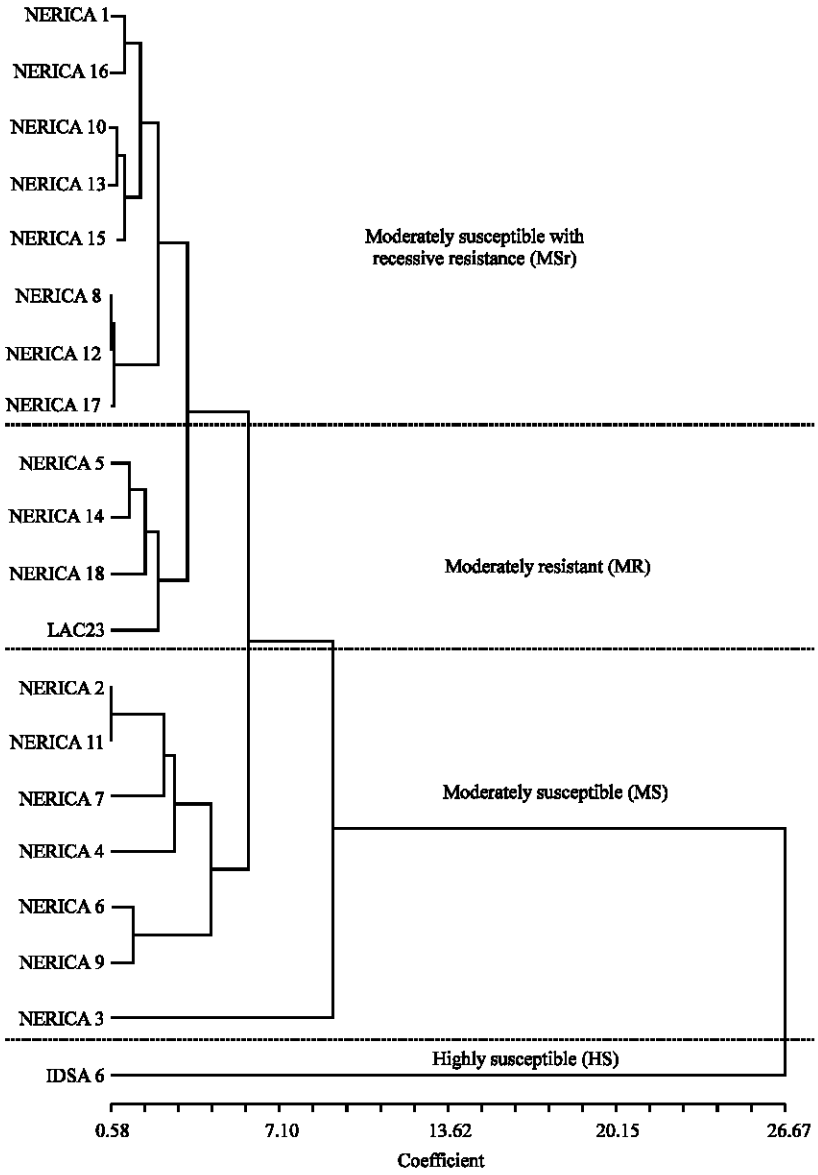

Fig. 2: Cluster dendrogram showing classification of 20 rice varieties level of resistance to termite damage using Unweighted Pair Group Method Arithmetic(UPGMA) mean principal component analysis

Table 4: Analysis of variance showing the effect of 20 rice varieties relative to days after sowing on termite damage at Kasua Mangani, Kaduna State, Northcentral Nigeria

Source	df	Sums of squares	Mean squares	f-value
Replication (R)	2	383.550	191.7750	5.10**
Variety (V)	19	5657.190	297.7470	7.92***
Day After Sowing (D)	1	198.455	198.4550	5.28*
VxD	19	458.113	24.1112	0.64ns
Error	78	2933.430	37.6081	
Total	119	9630.740	80.9306	

Ns: Not significant; *Significant at $p<0.05$; **Significant at $p<0.01$; ***Significant at $p<0.001$

susceptible (MS); while IDSA6 formed the only highly susceptible (HS) group (Fig. 2).

DISCUSSION

Developing resistant rice varieties is the simplest, cheapest and environmentally safest way of controlling crop insect pests. During the last 2 decades, spectacular progress has been achieved in the development of insect resistant varieties to major insect pests of agricultural crops (Dhaliwal and Singh, 2004). The NERICA rice varieties recently developed by the Africa Rice Center (WARDA) are becoming increasingly popular amongst farmers especially for their insect pest resistance quality. One of such insect pests is termites. Although,

little information is available on the yield losses and resistance/tolerance status of some major agricultural crops to termites, studies have shown that indigenous crops show more resistance/tolerance to termites than the exotic crops and this is presumably because indigenous crops have evolved defense mechanisms against the local termite population. According to previous studies, termite damage to crops and trees is more severe during dry spells or drought periods and farmers considered termite damage to be more severe in the dry months compared with the wet months (Nyeko and Olubayo, 2005). Thus, rice mildly resistant to termites damage during dry periods or droughts would be highly resistant to termites damage during periods of regular rainfall (Sileshi *et al*., 2005). The present study provides the basic information on the resistance status of upland NERICA rice varieties to termite damage in Northcentral Nigeria. The reactions (MR, MSr, MS and HS) of the 18 NERICA rice varieties to termite damage obtained in the present study suggest the presence of biotypes in termite populations (Nwilene *et al*., 2006). The three moderately resistant (MR) NERICAs (NERICA 5, NERICA 14 and NERICA 18) could be recommended as the most adapted rice varieties in termite prone areas of Northcentral Nigeria. Besides, the 7 moderately susceptible rice varieties with recessive resistance (MSr) (NERICA1, NERICA8, NERICA10, NERICA12, NERICA13, NERICA15 and NERICA17) could also be used by farmers in termite endemic areas in Northcentral Nigeria.

The results obtained in the present study are consistent with findings obtained from previous studies in Southwest Nigeria in which NERICA 1 and NERICA 5 were observed to be moderately resistant (MR) to termite attack (Nwilene *et al*., 2008). However, the confirmed moderately resistant (MR) NERICA 14 and NERICA 18 obtained in this study against termite damage in Northcentral Nigeria were not reported in earlier studies in Southwest Nigeria (Nwilene *et al*., 2008). In this perspective, there is probability that the three moderately resistant NERICAs rice varieties (NERICA 5, NERICA 14 and NERICA 18) obtained in this study could be tested on-farm in other termite prone areas such as Southwest Nigeria for use by farmers.

CONCLUSION

The present study provides a vital information on the resistance status of upland NERICA rice varieties to termite damage in Northcentral Nigeria. The three moderately resistant NERICA rice varieties (NERICA 5, NERICA 14 and NERICA 18) obtained in the study could be recommended to farmers for use against termite attack. The moderately resistant NERICA rice varieties could also be used by rice breeders and molecular biologists to develop marker assisted selection and pyramiding multiple resistance genes into rice cultivars. There is need for more comprehensive multi-location on-farm trials and studies to further evaluate the resistance status of theses 18 upland NERICA varieties across other agro-ecological zones in Nigeria where termite infestation is endemic.

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