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Relative Susceptibility of Some Sorghum Varieties to the Rice Weevil, *Sitophilus oryzae* L. (Coleoptera: Curculionidae)

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Abstract: The aim of the present study is to find alternative and safe ways for storing grains. A total of 36 sorghum varieties were screened for their relative susceptibility to *S. oryzae*. Varieties BES, ICSV111, ICSV247, ICSV1079BF and ICSH89009NG had a low index of susceptibility and were regarded as resistant. Varieties SINGE-2, SK5912, ICSV902NG, KSV 8, 18395 and ICSV 210 had a high index of susceptibility and were regarded as highly susceptible. The resistant varieties had low number of F_1 progeny emerging from them, had low percentage damage and weight loss. The susceptible varieties had high number of F_1 progeny, high percentage damage and weight loss. Grain hardness was found to be the overall factor responsible for resistance to *S. oryzae*.

Key words: Index of susceptibility, sorghum varieties, *Sitophilus oryzae*, % damage, % weight loss, grain hardness

INTRODUCTION

Sorghum *Sorghum bicolor* (L.) Moench (Graminae) or guinea corn as it is commonly called in most parts of Nigeria is one of the most important food crops in the Nigerian Savanna. Nigeria is the highest producer of sorghum in West Africa with over 6 million hectares devoted to sorghum. An estimated annual production of 9 million metric tons is mostly harvested by peasant farmers. Average yields on peasant farms are 500 kg ha^{-1} whereas yields of 1,800 to 3,000 kg ha^{-1} are obtained under improved technology (Aba, 2001).

It is used widely for brewing beer in Africa and most parts of the world because of its good malting qualities. It is a valuable raw material in the flour and baking/confectionary industries (ICRISAT, 1992). Sorghum grains are usually stored after harvest till the next harvest season for home consumption and for commercial reasons. Proper storage of sorghum grains in both rural families and bulk storage would not only help in bridging the existing marginal food gap, but would also contribute to health and nutrition by conserving grain quality (Lale, 2002).

Besides field insects and diseases, storage insects limiting grain sorghum storability include: the rice weevil, *Sitophilus oryzae* L. which is the most important pest. Others include *Sitophilus zeamais* (Motch), *Sitotroga cereallela* (Olivier) (Lepidoptera: Gelechiidae), Flour beetles, *Tribolium* spp. (Coleptera: Tenebrionidae), *Rizopertha dominica* Fab, etc. *S. oryzae* is cosmopolitan, being found in both tropical and temperate regions of the world. Both adults and larvae feed on sorghum grains, which may often be damaged beyond use. Larvae tunnels and feeds within the grain. The pest is most active under humid conditions and this is the peak period of infestation (Bamaiyi *et al*., 1998). Attack makes the grain prone to mould attack and caking (Wood and Ambridge, 1996). Ohiagu (1983) found losses to be as high as 76.86% when sorghum was stored on head in rhumbus/earth granaries without insecticidal treatment. Caswell (1978) estimated that 1.4% of sorghum produced in northern Nigeria, the growing zone of sorghum, was lost annually to store insect pests, particularly *Sitophilus* spp. Post-harvest cereal grain losses to insect pests in small-farm tropical agriculture can routinely exceed 30%

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because of lack of good storage facilities and the high humidity prevalent in the tropics, especially Nigeria (Ramputh *et al*., 1999). Although grain resistance is rarely considered as a selection criterion in conventional breeding programs, in traditional agriculture farmers are acutely aware of the levels of resistance in various cultivars available to them. Traditional knowledge of storability can be accurate perhaps because of its obvious importance to farmers without other means of protecting grains. Most Nigerian farmers are peasants and their level of literacy is quite low, thus, there is the need to find alternative and safe ways of storing their grains, considering the huge losses of cereal grains to insect pests and the risk of pesticide residue in the treated grains, which is the subject of this study.

MATERIALS AND METHODS

The grains of 36 sorghum varieties were screened for susceptibility to *S. oryzae* at the storage entomology laboratory of the Department of Crop Protection, Institute for Agricultural Research, Ahmadu Bello University, Zaria, Nigeria. The experiments were carried out during the periods June-October, 2004 and repeated in 2005. This period was chosen because *S. oryzae* is known to be at its peak period of activity between the months of July and October in Samaru, Zaria (Caswell, 1980). It is therefore thought that any variety that shows resistance to the pest during this period is indeed resistant. The temperature and relative humidity was monitored using a thermohydrograph and ranged between 25-27°C and 70-80%, respectively.

The grains were fumigated in airtight drums with phostoxin tablets to disinfect them of available insects, if any. The varieties screened are given on Table 1.

S. oryzae were obtained from the stock culture at the storage laboratory of the Department of Crop Protection, IAR at Samaru. A large culture was maintained which was used for infesting the sorghum samples. The moisture content of the samples ranged from 9.12-11.43% which was determined using the oven-dry method (Pixton, 1967).

For each sorghum variety, three replicates of 200 kg each were placed in 1 L capacity kilner jars and infested with 10 pairs adult *S. oryzae* in each replicate. The jars were arranged in a completely randomized design on a laboratory bench.

The parents *S. oryzae* were sieved out after 10 days of infesting the grains when they would have laid their eggs. The insect count commenced 35 days post-infestation when the F_1 progenies would have started emerging, the mean developmental period from egg to adult is 35 days (Howe, 1952). Counts of emergent adults were taken daily using a tally counter and the number recorded for each sample. Sampling for adult emergence continued up to the 50th day when most F_1 progenies would have emerged. The index of susceptibility was calculated from the insect number using the formular of Dobie (1977) as follows:

$$\text{Index of susceptibility} = \frac{\text{Log}_e\ F}{D} \times 100$$

Where F = Total number of F_1 progeny emerged
D = Median developmental period (days), estimated as the time from the middle of the oviposition period to the emergence of 50% of the F_1 progeny

The percentage grain damage and weight loss were assessed.

RESULTS

The analysed data from the evaluation of 36 sorghum grain samples for susceptibility to post harvest infestation with *S. oryzae* is presented in Table 1. Using New Duncan Multiple Test

Table 1: Effect of some sorghum varieties on emergence of adult *S. oryzae*

Varieties	F_1 adult emergence	Index of susceptibility	Median developmental period (days)	Damage (%)	Weight loss (%)
SK5912	684.00_{a}	19.80_{a}	32.97_{t}	16.78_{b}	8.04_{b}
SINGE-2	697.70_{a}	18.07_{h}	36.23_{ijk}	17.74_{a}	9.08_{a}
ICSV902NG	620.70_{b}	17.55_{c}	36.63_{hi}	14.38_{c}	7.23_{c}
ICSV1002	324.70_{gh}	17.42_{c}	33.20_{c}	$8.56d_{e}$	4.09_{gh}
18495	444.30_{d}	16.90_{d}	36.07_{ijk}	10.84_{d}	4.72_{e}
KAMPTI	319.70_{hi}	19.87_{d}	34.20_{s}	8.19_{fg}	4.01_{gh}
KSV 8	517.30_{c}	16.84_{d}	37.10_{efg}	13.96_{c}	6.45_{d}
SINGE-1	316.70_{hi}	16.74_{de}	34.40_{rs}	8.22_{fg}	4.03_{gh}
84-5-130	358.00_{f}	16.66_{de}	35.30_{nop}	9.88_{e}	4.21_{g}
ICSV210	419.00_{c}	16.60_{de}	36.37_{ij}	10.48_{d}	4.46_{f}
MORI	323.00_{ghi}	16.57_{de}	34.87_{pq}	8.53_{f}	4.04_{gh}
ICSV905NG	342.30_{fg}	16.45_{def}	35.47_{mno}	9.38_{e}	4.11_{gh}
34433	267.30_{kl}	16.34_{efg}	34.20_{s}	7.47_{hi}	3.17_{i}
ICSV424	302.30_{ij}	16.00_{fgh}	35.70_{lmn}	8.16_{fg}	3.19_{h}
ICSV554	273.70_{kl}	15.94_{gh}	35.20_{opq}	7.50_{hi}	3.20_{i}
BOPEN-R5	230.00_{no}	15.80_{hi}	34.40_{rs}	7.04_{i}	2.87_{i}
FIRKAN	242.70_{mn}	15.70_{hi}	34.97_{pq}	7.22_{i}	3.01_{ij}
85-4BF	229.70_{no}	15.57_{hi}	34.90_{pq}	7.10_{i}	2.93_{i}
ICSV1049	281.70_{kl}	15.54_{hi}	36.30_{ij}	7.91_{gh}	3.19_{l}
L. 533	255.00_{lm}	15.47_{i}	35.83_{klm}	7.40_{hi}	2.06_{ij}
84-W-830	212.00_{o}	15.38_{l}	34.83_{qr}	6.95_{i}	2.61_{k}
1023BF	241.70_{mn}	14.71_{j}	37.30_{ef}	7.14_{l}	2.92_{j}
White mutant	166.30_{p}	13.65_{k}	37.40_{e}	5.47_{i}	2.20_{l}
ICSH89002NG	152.30_{pq}	13.49_{kl}	37.20_{ef}	5.42_{i}	2.20_{l}
16-5BF	147.00_{pqr}	13.41_{l}	37.20_{ef}	5.45_{l}	1.80_{m}
IS 9928	127.70_{rst}	13.08_{lm}	37.07_{efgh}	4.93_{l}	1.76_{m}
ICSV400	125.00_{st}	13.07_{lm}	36.93_{fgh}	5.01_{l}	1.77_{m}
ICSV655	117.70_{st}	12.85_{m}	37.10_{efg}	3.09_{k}	1.75_{m}
IS 21658-Y	113.70_{st}	12.32_{n}	38.40_{d}	3.56_{k}	1.43_{n}
FRAMIDA	134.30_{qrs}	12.31_{n}	39.80_{c}	5.38_{l}	1.76_{m}
ICSV1007	110.70_{t}	12.09_{n}	38.90_{d}	3.31_{k}	1.18_{o}
ICSV247	59.67_{u}	11.14_{o}	36.67_{ghi}	1.32_{i}	0.44_{p}
ICSV1079BF	70.70_{u}	11.09_{o}	38.40_{d}	1.41_{l}	0.60_{p}
ICSH89009NG	48.70_{v}	11.01_{o}	35.20_{opq}	1.21_{l}	0.25_{q}
ICSV111	43.00_{v}	10.05_{p}	37.13_{ef}	1.6_{e}	0.57_{q}
BES	27.70_{v}	7.72_{q}	42.97_{a}	0.30_{m}	0.13_{q}

Values followed by the same letter(s) are not significantly different at 5% level of probability using NDMRT

(NDMRT), the means from the 36 sorghum varieties screened showed that in each of the parameters shown in Table 1 there were significant ($p<0.05$) differences among most varieties.

At 50 days post-infestation with *S. oryzae*, the mean numbers of F_1 progenies that emerged from the 36 different sorghum varieties ranged from 27.70 in BES to 697.70 in SINGE-2. Varieties with significantly higher number of F_1 progenies were SINGE-2, SK5912, ICSV902NG, KSV8, 18495 and ICSV210. Using NDMRT, there was no significant difference ($p>0.05$) in the number of F_1 progenies from these varieties. The varieties with significantly lower emergence were ICSV1079BF, ICSV247 ICSH89009NG, ICSV111 and BES which recorded the least progeny emergence.

The median developmental period from egg to adult for *S. oryzae* ranged from 32.97 on SK5912 to 42.97 days on the variety BES (Table 1). The general trend appeared to be similar to that for F_1 adult emergence. Varieties with high F_1 adult emergence tended to have short median developmental periods. The reverse was the case with those that had low F_1 adult emergence.

The index of susceptibility ranged from 7.72 in variety BES to 19.80 in SK5912 (Table 1). Varieties SK5912, SINGE-2, ICSV1002 and ICSV902NG were among those with higher indices. Those varieties with the lowest indices of susceptibility were ICSV111 and BES.

Figure 1 is a frequency histogram based on the index of susceptibility determined for the 36 sorghum varieties. Generally, the data is almost normally distributed with a mean of 13.76 and a

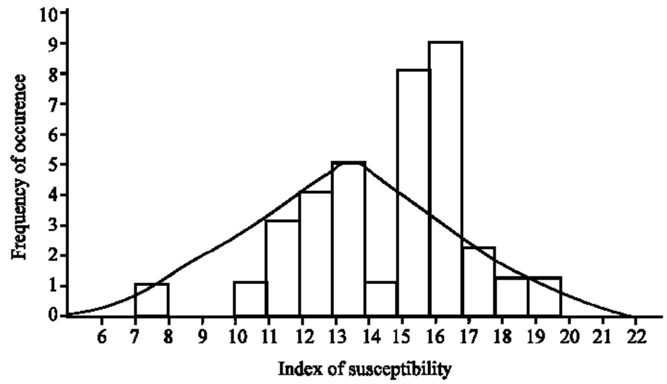

Fig. 1: Frequency distribution of relative susceptibility of 36 sorghum varieties to *S. oryzare*

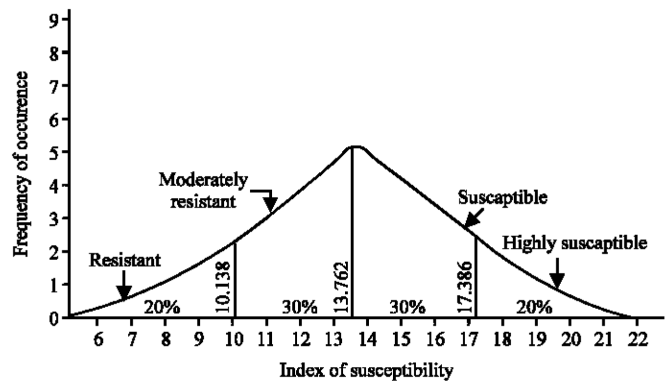

Fig. 2: Resistance scale developed on a normal distribution curve

standard deviation of 2.52 but slightly skewed towards the higher indices. For convenience however, a normal distribution curve was superimposed on the histogram which was then used to classify the varieties into four groups ranging from resistant to highly susceptible (Fig. 2) according to Dobie (1977). Those varieties of sorghum with an index of susceptibility less than 10.14, representing the lower 20% of the observations were regarded as resistant. Those with index of susceptibility between 10.15 and 13.76, representing the next 30% of the observations (i.e., 20>50%) were regarded as moderately resistant. The varieties with index of susceptibility between 13.77 and 17.39, representing the next 30% of the observations (i.e., 50>80%) were regarded as susceptible. Those with index of susceptibility of over 17.40, representing the upper 20% of the observations (i.e., 80>100%) were regarded as highly susceptible (Dobie, 1977).

S. oryzae caused greatest kernel damage in varieties SINGE-2 and SK5912, the former sustaining significantly higher damage ($p<0.05$) than the latter. Varieties ICSV111, ICSV1079BF, ICSV247 and ICSH89009NG were among the least damaged and yet sustained significantly higher ($p<0.05$) damage than BES.

The percentage weight loss shown in Table 1 ranged from 0.13 for variety BES to 9.08 for variety SINGE-2. Varieties SINGE-2, SK5912, ICSV902NG, KSV8, 18495 and ICSV210 generally lost the most weight but each lost significantly ($p<0.05$) more weight than the others in a descending order. Varieties ICSV1079BF, ICSV111 and ICSV247 had the least weight loss but had the greatest loss of seed weight than ICSH89009NG and BES.

DISCUSSION

The results of the present study showed wide variability between the varieties with respect to the numbers of F_1 adult emerging, median developmental period, index of susceptibility, percentage damage and weight loss. These taken together, reflect the inherent ability of a particular variety to resist pest attack. These may be largely attributed to the differences in the physical characters among the grains of the different sorghum varieties.

The varieties identified through the susceptibility index as susceptible included SINGE-2, SK5912, ICSV902NG, KSV8, 18495 and ICSV210 supported more *S. oryzae* populations and had high indices of susceptibility and thus suffered more damage and weight loss. The varieties identified through the susceptibility index as resistant included BES, ICSH89009NG, ICSV247, ICSV1079BF and ICSV111. These supported fewer insects developing from them, thus, suffered less damage and weight loss as a result of *S. oryzae* feeding.

Adesuyi (1979) reported that factors known to be responsible for the resistance of stored products to attack by insects e.g., *Sitophilus* spp. included presence of toxic alkaloids or amino acids in some stored products, insect feeding deterrents, seed coat characteristics that discourage oviposition, digestive enzyme inhibitors and kernel hardness. This agrees with the result of this study as grain hardness was found to be mainly responsible for resistance of sorghum grain to *S. oryzae*. Ramputh *et al.* (1999) found significant relationship between grain damage and soluble phenolic content to be a cause and effect relationship. They also reported that phenolics are well known to be directly involved in insect resistance in many plants by antixenosis and antibiosis mechanisms. The effect of phenolics on resistance to *S. oryzae* was not investigated in this study due to lack of facilities but it is highly supported as a factor for resistance. That the varieties with high index of susceptibility had shorter periods for completion of development of *S. oryzae* whilst those with low index of susceptibility had longer periods within which development of *S. oryzae* was completed agrees with Dobie (1984) who reported that resistant maize varieties extended the developmental period of *S. zeamais.* It can be concluded that if resistant sorghum varieties extend the developmental period and cause a high mortality of the developing *Sitophilus* spp (Dobie, 1974), the post harvest loss incurred during storage of farm produce will be greatly minimized.

Those varieties with low indices of susceptibility, BES, ICSH89009NG, ICSV247, ICSV1079BF and ICSV111 can thus, be stored for longer periods without fear of insect damage. These varieties are best for farmers in these days when the whole world is becoming so sensitive to pesticide residue in treated food produce. Those with high indices of susceptibility can only be stored for longer periods with the help of preserving materials.

REFERENCES

Aba, D.A., 2001. Malting quality of sorghum varieties. I.A.R. Cropping Scheme Report.

Adesuyi, S.A., 1979. Relative resistance of some maize varieties to attack by *Sitophilus zeamais*. In: Nigerian Stored Products Research Institute. 14th Annual Report.

Bamaiyi, L.J., I.I. Uvah, M.C. Dike and I. Onu, 1998. Relative resistance of sorghum varieties to the rice weevil, *Sitophilus oryzae*. J. Sustainable Agric., 13: 5-11.

Caswell, G.H., 1978. Damage to sorghum in northern parts of Nigeria. Samaru Miscellaneous Papers, 8.

Caswell, G.H., 1980. A review work done in the Entomology section of the Institute for Agricultural Research on the pests of stored grain. Samaru Miscellaneous Papers, 13.

Dobie, P., 1974. The laboratory assessment of the inherent susceptibility of maize varieties to post harvest infestation by *S. zeamais*. J. Stored Prod. Res., 10: 179-183.

Dobie, P., 1977. The contributions of tropical stored products centre to the study of insect resistance in stored maize. Trop. Stored Prod. Inform., 3: 4-7.

Dobie, P., 1984. Biological methods for integrated control of insects and mites in tropical stored products 1. The use of resistant varieties. Trop. Stored Prod. Inform., 48: 4-7.

Howe, R.W., 1952. The biology of the rice weevil, *Calandra oryzae*. Ann. Applied Biol., 39: 48-53.

ICRISAT, 1992. Annual Report. International Cereal Research Institute for Semi-Arid Tropics. Patancheru, India, pp: 76.

Lale, N.E.S., 2002. Stored Products Entomology and Acarology in Tropical Africa. 1st Edn., Mole Publications (Nig.) Ltd., Maiduguri, Nigeria, pp: 204.

Ohiagu, C.E., 1983. Storage of sorghum in Jute and woven sacks under different management practices. Prevention of Post Harvest Food Losses. Technical Report Project 1 PFL/NIL/003.

Pixton, S.W., 1967. Moisture Content-Its significance and measurement in stored products. J. Stored Prod. Res., 3: 35-47.

Ramputh, A., A. Teshome, D.J. Bergvinson, C. Nozzolillo and J.T. Arnason, 1999. Soluble phenolic content as an indicator of sorghum grain resistance to *Sitophilus oryzae* (Coleoptera: Curculionidae). J. Stored Prod. Res., 35: 57-64.

Wood, A. and L. Ambridge, 1996. A guide to Insect Pests of Nigerian Crops. Identification, Biology and Control. Natural Resources Institute, Overseas Development Administration, pp: 253.