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Resistance of Cassava Cultivars to Green Spider Mite, *Mononychellus tanajoa* (Bondar) infestation in Nigeria.

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ABSTRACT

One thousand cassava cultivars in the germplasm were screened for resistance to the cassava green spider mite. *Mononychellus tanajoa* (Bondar) under natural field infestation. Twenty-one cultivars were identified as possessing levels of tolerance or resistance to the mite. These were subjected to artificial populations of *M. tanajoa* in the greenhouse in order to confirm either their tolerance or resistance.

Of the twenty-one cultivars, TMS 4(2) 1425 was found to be the most tolerant to *M. tanajoa* infestation, followed by 74/538, Anti - Ota, 73/93, 30195 and 1531 in that order. These six cultivars supported fewer numbers of mites and four of them, TMS 4(2) 1425, 73/93, 74/538, 74/538 and Anti - Ota, had pubescent leaves associated with resistance. Mite density and damage were not correlated with variations in leaf hydrogen cyanide content. This factord did not appear therefore to have influenced the mite resistance observed in the cassava cultivars.

INTRODUCTION

The green spider mite. *Monocychellus tanajoa* (Bondar) together with cassava mealybug, *Phenacoccus manihoti* (Mat - Ferr.) were first noticed in Nigeria in 1979 (Akinlosotu and Leuschner, 1981). Together, they can cause yield losses as high as 80%, with an average of 30% which is considered a conservative figure (International Institute of Tropical Agriculture (I.I.T.A.), Ibadan, 1988).

The use of pesticides, cultural control and biological control agents have not yet alleviated the problems of *M. tanajoa* on

cassava in Nigeria. It is, therefore, necessary to test alternative methods of control such as the production of resistant cultivars. A stable host plant resistance offers the best and most practical long range solution for controlling cassava mites because it is economical, easy to use and compatible with other control methods. To develop a resistant cassava clone, the following steps are necessary; firstly, the identification of genetically conditioned resistance, secondly, the development of a reliable evaluation scheme and thirdly, determination of breeding methods to incorporate this resistance into a commercially acceptable variety. Byrne *et al.* (1983) have extensively reviewed host-plant resistant to mites.

To date, more than 2,000 varieties of cassava from Centro Internacional de Agricultura Tropical (CIAT) germplasm bank have been screened from *Mononychellus* mite resistance (Bellotti et al., 1985). Results showed that 43 promising cultivars for resistance have been selected. Cassava has also been screened for resistance to Mononychellus spp. In Trinidad (Yaseen and Bennett, 1977); Tanzania (Shukla, 1976); Rwanda and Uganda (Nyiira, 1978); Ibadan, Nigeria (I.I.T.A., 1982); in Burundi (Ndayiragije, 1987) and Kenya (Robertson and Robertson, 1987). Although many of these evaluations were minimally replicated (over one site or in one year), it is evident that all cassava varieties are attacked by mites (i.e. no immunity exists) and that genetically conditioned resistance exists (Byrne *et al.*, 1983).

Resistance to mites has been related to lower fecundity non-preference, increased mortality and increased developmenta time, which have been attributed to botl chemical factors and morphological charac ters such as pubescence (van de Vrie *et al.* 1972). Both pubescence and hydroger cyanide (HCN) content in cassava leaves have been suggested as resistance factors for mites. The objective of this study was to evaluate a wide range of cassava germplasm for resistance to *M. tanajoa* and to try to find a probable mechanism involved in the resistance.

MATERIALS AND METHODS

Field Evaluation:

The cassava germplasm at the National Root Crops Research Institute (N.R.C.R.I.), Umudike is made up of collection from Nigeria. A total of 1,000 cassava cultivars were planted in rows of 6 stands per cultivar at a spacing of 1 metre apart on 1 metre ridges in April 1981. Field evaluation was aimed at eliminating susceptible cultivars and to select promising materials for more detailed studies in the greenhouse.

The cassava cultivars were screened in the field for resistance to *M. tanajoa* under natural field infestation. Numerous rows of susceptible cultivars were interspersed with the test cultivars to serve as "spreaders" of times. The evaluation period was during the dry season (November 1981 to February, 1982), which coincided with the period when mite attack and damage on cassava are most severe. Leaf damage was rated on a scale of 0-5 (Table 1) using visible symp-

Table 1: Mite Damage (Severity) Scale

Level of Damage	Description
0	No mite damage.
1.	Few spots on terminal leaves, 10% of foliage affected.
2.	More spots on leaves, 30% of foliage affected.
3	Spots more severe, 50% of foliage affected. Terminal young leaves reduced in size and spindle-shaped.
4.	Spots very severe, 70% of foliage affected.
5.	100% of foliage affected/defoliation.

toms of damage which were whitish/yellowish spots on the adaxial surfaces of cassava leaves. Observations were made at monthly intervals on the six plants per cultivar for four months.

Greenhouse Evaluation:

Twenty-one cassava cultivars selected after field screening as being either tolerant or resistant to *M. tanajoa*, were subjected to further evaluation in the greenhouse at N.R.C.R.I. Umudike. The cultivars were planted in plastic buckets and the plants arranged in a completely randomized design. Each cultivar was replicated four times. At ten weeks after planting, when the plants were about 30cm high and had an average of ten leaves per plant, each plant was artificially infested with 100 mites (nymphs and adults).

The mites were randomly placed with a camel's hair brush on 1-5 opened leaves (counting from the top) of each plant.

Mite damage was assessed by visual damage rating on cassava foliage on a scale of 0 - 5 (Table 1). Host plant resistance was classified as follows: 0 -1 = resistance; 2-3 = intermediate or moderate resistance (tolerance) and 4-5=susceptible. Four leaves were sampled per cultivar for the number of mites at monthly intervals for 3 months from December 1982 to March, 1983. Ten leaf discs per cultivar, each measuring 12.6 square millimetres, were punched out with a cork borer. The number of hairs or trichomes on the abaxial surface of the leaf discs were counted in the unit area with the aid of stereo microscope (Mag. 150). The leaves of the cassava cultivars were analysed for hydrogen cyanide (HCN) content using the method of Association of Official Analytical Chemists (A.O.A.C.) (1975) and the values were correlated with mite resistance.

RESULTS AND DISCUSSION

Field Evaluation

Figure 1 shows mite damage scores on 1,000 cassava cultivars in the germplasm. Based on the rating scale, 423 cultivars (42.3%) had damage scores of 0-2, indicating some resistanve to mite attack; 91 cultivars (9.1%) showed intermediate resistance or tolerance with a damage score of 3, while 486 cultivars (48.6%) were highly susceptibe with a damage score of 4-5. From the results, the cassava cultivars with scores of 0-3 were the promising materials which qualififed for further evaluation in the greenhouse while those with scores of 4-5 were discarded.

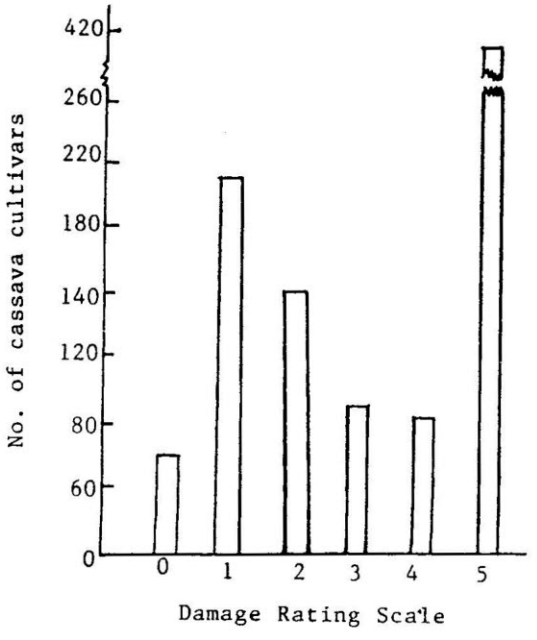

Fig. 1: Mite damage scores of cassava cultivars in the germplasm.

Greenhouse Evaluation

Table 2 shows the cassava cultivars evalu ated in the greenhouse for resistance to *M tanajoa*. The mean mite damage scores in dicate that six cultivars namely: TMS 4(2 1425, 74/538, Anti-Ota, 73/93, 30195 an 15341, in that order, were tolerant to *M tanajoa* attack and showed less damag symptoms than the rest. The other cultivar were susceptible to mite attack with score ranging from 3.5 to 4.5. The tolerant culti vars supported fewer mites than the suscep tible cultivars (Table 2). Shukla (1976) i Tanzania showed that susceptible cassav varieties harboured more mites and that th population decreased on moderately resis tant and resistant varieties. This presen study supports the observation by Shukl (1976), that there are differences in tole ance to leaf damage. From the regressio analysis of mite damage score of mite den sity (Fig. 2), the correlation was positive an significant at 0.05 level ($r = 0.90$). Thi indicates that mite damage generally in creased with mite density. A similar resu was obtained by Byrne (1980) who showe that the correlation between mite damag and densty was highly significant ($r = 0.72$

Observations under the stereo micrc scope revealed that four out of six cultiva which showed tolerance to *M. tanajoa* a tack possessed hairs or trichomes. Th mean number of hairs on the leaf discs, bot on the ribs and blades, are shown in Tabl 2. The hairs make it difficult for mites to re or crawl on the leaf surfaces and it possible that the hairs also serve as obstacl to feeding. The cultivar, TMS 4(2) 142 which had the highest number of hairs w

Table 2: Cassava cultivars evaluated for resistance to M. tanajoa

Cultivars	Damage score (0-5)	Mite No. per leaf	Presence of hair *	Mean No. of Hairs Rib (± SD)	Blade (± SD)	HCN (mg/kg)
TMS 30395	3.5bc	42.3ef	-			345.2
TMS 30211	4.0ab	64.3a	-			513.4
30218	4.0ab	53.3bcd	-			646.0
TMS 30572	4.0ab	58.0b	-			278.8
TMS	4(2)1425	2.0e 12.0g	+	64.3±12.0	17.4±2.7	579.7
1531	3.0cd	43.0e	-			612.8
30195	3.0cd	35.0f	-			663.0
U/41044	4.0ab	60.5ab	-			562.7
73/93	2.7de	16.3g	+	35.5±11.2	11.2±2.8	498.0
TMS 30555	4.0ab	59.0ab	-			326.4
74/538	2.0e	13.3g	+	13.5±2.8	6.9±1.9	555.4
Anti-Ota	2.3de	20.0g	+			209.1
77/97	3.5bc	45.0de	-	27.2±5.5	8.7±2.6	351.3
Nwajuwa	4.5a	44.0e	-			253.2
Um.C3	3.8abc	54.8bc	-			321.0
77/103	3.5bc	45.0de	-			290.7
75/720	3.5bc	46.5cde	-			302.6
75/714	3.5bc	46.5cde	-			285.0
73/337	4.0ab	50.5bcde	-			332.0
Nwugo	3.5bc	44.8de	-			270.3
77/1	3.5bc	47.5cde	-			268.5

*Key
(-) Absent
(+) Present
Figures followed by similar letter within the same column are not significantly different at 5% level, using Duncan's New Multiple Range Test.

the most tolerant material. This indicates a relationship between hair density and resistance. I.I.T.A. (1987) reported that in a three-year cassava trial, TMS 4(2) 1425 showed moderate levels of resistance to both cassava green mites and cassava mealybug.

A similar observation was recorded on cassava by Shukla (1976). He found that the most important feature of the resistant varieties was the presence of dense pubescence which was entirely absent in the suceptible varieties. This clearly suggest that pubescence can serve as a marker to isolate mite-tolerant/resistant cassava varieties. At I.I.T.A. (1981), it was observed that nearly all cassava cultivars showing varying degrees of mite resistance had trichomes on the young top leaves.

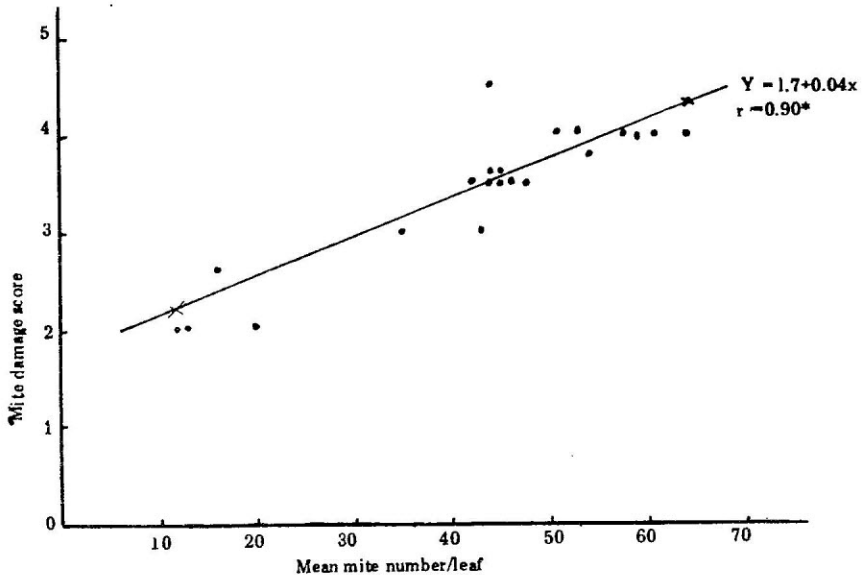

Fig. 2: Effect of mite population on foliar damage ratings of 21 cassava cultivars in the greenhouse.

However, the numbers of trichomes per square millimetre showed that there was a clear difference between the susceptible and resistant types. This present study suggests that the degree of resistance might depend on the intensity of pubescence as indicated by the pubescence pattern in the tolerant cultivars. Leaf pubescence therefore appears to be associated with resistance to *Mononychellus* (Shukla, 1976; I.I.T.A., 1983; Byrne *et al.*, 1982). Studies at CIAT also showed that resistance to mites is highly heritable and that this resistance is probably polygenic; it should therefore be a stable resistance (Bellotti *et al.*, 1985).

The regression analysis of mite damage score on hydroden cyanide (HCN) content in the cassava leaves showed that this was not significant at 0.05 level (r=0.30). Similarly, the regression analysis of mite density of HCN content in the cassava leaves showed that this was not significant at 0.05 level (r = -0.19). For the two tolerant cultivars (1531) and 30195) which possessed no hairs but had high HCN content in the leaves, it seemed that HCN might be a factor in the tolerance. Wood (1966) had suggested that when cassava plants are attacked by insects, linamarin is converted to HCN by the enzyme linamerase and HCN is used to repel the attack. HCN content as well as pubesecence have been suggested to be mite resistance factors. Shukla (1976) made a contrary observation on HCN content as a mite resistance factor because a majority of the bitter varieties which contain high HCN were highly susceptible to mite attack and attempts to isolate resistant genotypes among the bitter varieties failed. It may be possible that the

released HCN could be detoxified by some enzymes in the mite's digestive system into thiocyanate which may be used for protein synthesis and then converted to a product used as food. The claim that HCN content of the leaf confers resistance to the mite pests in India (*T. telarius*, *O. biharensis* and *E. orientalis*) (Maini and Lal, 1977) has not been substantiated. In the case of *Mononychellus* sp., a low positive correlation between mite damage and leaf HCN was obtained (CIAT, 1974). Yen *et al.* (1984) did regression analysis and indicated a positive correlation between mite population density and cyanogenic glucoside levels in leaves of 23 cassava varieties. However, measurement of resistance showed that mite infestation was not associated with low leaf-cyanide varieties (Nestel and Cock, 1976). Muaka - Toko (1981) showed that the cyanide content did not contribute to resistance of cassava to *M. tanajoa*. The selected tolerant cassava seedlings and clones even contained lower cyanide than the susceptible clones.

Montaldo (1972) reported differential resistance to spider mites in cassava cultivars in Venezuela. He showed that three cultivars were resistant to *Eotetranychus planki* McGregor (=*M. planki*). Nyiira (1972) reported varying levels of *M. tanajoa* infestations and differing degrees of susceptibility related to cassava varieties in Uganda. Dabrowski (1972) indicated that the adverse effect of resistant plants to phytophagous mites might decrease mite fecundity, increase mite mortality and involve anomalous mite behaviour on the resistant host plant. These effects eventually cause a decrease of mite population on resistant plants in comparison to a susceptible variety.

Plants experience pressures from the environment, from pathogens, arthropod pests and competing plant species and, therefore, must evolve protective mechanisms with which to deal with these multiple influences. It is not advantageous for the plant to develop many structures and chemicals that only serve for defence; it is only necessary for it to develope a few effective mechanisms by which it would survive pest attack. Evidence for this conservation of energy for defence is that a variety may possess several mechanisms or resistance, but one may be the most important factor for resistance. In this study, it was indicated that pubescence might be the most important factor that contributes to mite resistance. It is expected that the selected tolerant cultivars would serve as a genetic resource for plant breeders who are engaged in the effort of developing stable resistance to the green spider mite of cassava.

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