Der Tropenlandwirt, Zeitschrift für die Landwirtschaft in den Tropen und Subtropen
88. Jahrgang, 1987, S 5 – 10

Effects of Mealybug *(Phenacoccus manihoti)* Infestation on Cassava Yield Components and Plant Tissue Quality

Auswirkungen des Befalls durch die Schmierlaus *Phenacoccus manihoti* auf die Ertragsbildung und Qualität des Pflanzengewebes bei Kassave *(Manihot esculenta* CRANTZ*)*

by D.K.G. Ayanru *)

1 Introduction

The cassava mealybug *(Phenacoccus manihoti* MAT-FERR.*)* was reported only recently in Nigeria (AKINLOSOTU and LEUSCHNER, 1981). Since then, its outbreaks on cassava have reached epiphytotic proportions in the country and other cassava growing regions of Africa (NWANZE et al., 1979; LEUSCHNER, 1980).

Integrated control measures, involving early planting (ANON, 1980), insecticides (ATU and OKEKE, 1981) and predators (BENNETT and GREATHEAD, 1978), among other, are advocated. But as the measures are yet to have major impacts, the pest still occurs extensively on cassava.

The consequences of mealybugs infestation in cassava are far-reaching. These include defoliation, growth abnormalities, reduced yields or total crop failure (NWANZE, 1982). However, yield loss data for Nigeria are not yet readily available, while the effects of the pest on tissue quality have received only limited attention. This paper reports on the changes in yields, sugars, metabolizable energy and protein contents in cassava stem and tuber tissues, as affected by mealybug infestations.

*) D.K.G. Ayanru, Associate Professor, Department of Microbiology, University of Benin, P M B 1154, Benin City, NIGERIA

2 Materials and Methods

Two-bud-node stem cuttings of a clone (TMS 41044) of cassava *(Manihot esculenta* CRANTZ*)* were planted 1 m apart on pairs (split plots) of 1 m wide x 14 m long rows in field plots at Ugbowo, Benin City, on June 22 1983. This provided a randomised block design in which 10 plants in each of the paired rows were replicated four times in each of three blocks.

On Aug. 22 1983 plants were side-dressed with fertilizers at the rates of 60, 60 and 60 kg of N, P_2O_5 and K_2O/ha, respectively.

Plants in one of each paired rows spaced 4 m apart were sprayed at 3-weekly intervals with Folithion 200 (Fenitrothion) at a formulation of 250 ml/100 l water, between Oct. 22 1983 and March 12 1984, using a Wambo sprayer. On April 22 1984, plants were evaluated for canopy height, stem diameter (at 10 cm from ground level), defoliation and infestation by the cassava mealybugs *(Phenacoccus manihoti* Mat-Ferr.). Defoliation was assessed visually and on the basis of dry leaf wt. per plant, while infestation scores were based on a scale of O (no infestation) - 5 (severe infestation) modified after ATU and OKEKE (1981). Then, plants were harvested for fresh stem and tuber yields, and samples were dried and processed according to the method of RAGUSE and SMITH (1965) for the determination of tissue dry matter, total carbohydrates and protein contents.

Quantitative determination of sugars, following hydrolysis of complex tissue carbohydrates with HCL, was done by the Benedict's solution titration method (LAMBERT and MUIR, 1959). From the amount of sugars in a tissue, metabolizable energy contents (Kcal kg^{-1}) were estimated according to VOGEL (1975). Percentage crude protein was determined by the Kjehdahl method (LAMBERT and MAIR, 1959). The Student's test (ALDER and ROESSLER, 1962) was used to analyse paired data statistically.

3 Results

Folithion-sprayed plants were free from mealybug infestation symptoms, while non-sprayed ones were severely infested by the pest and completely defoliated. Data on infestations, yields and other parameters are presented in Table 1. Fresh stem an tuber yields and canopy heights of non-infested plants exceeded highly significantly (P = 0,01) those of infested stands. Compared with stem tissues of non-infested cassava, those of infested ones were dehydrated, while the tuber tissues of the latter were more watery than the former.

Sugars and metabolizable energy contents of stems and tubers were higher in non-infested than infested ones. On the contrary, the protein contents of these tissues were enhanced (> 88%) in infested plants as compared with non-infested ones (Table 2).

Tab. 1: Yields and other tissue parameters from mealbug-infested and non-infested cassava

Parameter	Non-infested	Infested	Difference (%) [1]
Infestation score[3]	0	5	100[2]
Defoliation status[4]	52.69	0	100[2]
Fresh tuber yield (g/plant)	1258[5]	704	44[2]
Dry tuber yield (g/plant)	468	187	60[2]
Dry matter-tuber (%)	37.22	26.61	28.51[2]
Fresh stem yield (g/plant)	585	240	57[2]
Dry stem yield (g/plant)	121	74	39[2]
Dry matter-stem (%)	20.68	30.70	48[2]
Canopy height (cm)	97.56	74.78	23[2]
Stem diameter (at 10 cm from ground level)	1.96	1.64	16

[1]Difference (%) = $\frac{\text{Non-infested - Infested}}{\text{Non-infested}} \times 100$;

differences with [2] are significant at the 1% level.

[3]Scores based on a scale of 0 (no infestation - 5 (severe infestation)

[4]Weight of dry foliage (g/plant).

[5]Means of 40 plants.

Tab. 2: Sugars and some other constituents of tissues from mealybug-infested and non-infested cassava

Constituent	Tuber tissue			Stem tissue		
	Non-infested	Infested	Difference %[1]	Non-infested	Infested	Difference %[1]
Total carbohydrates (%)	70.92[3]	65.13	7.90[2]	28.41	19.06	32.91[2]
Metabolizable energy (kcal/kg)	1033	951	7.94[2]	415	278	33.01[2]
Nitrogen (%)	0.42	0.79	89.50[2]	0.44	0.84	88.74[2]
Crude protein (%)[4]	2.63	4.95	88.21	2.75	5.26	91.27[2]

[1]Difference (%) = $\frac{\text{Non-infested - Infested}}{\text{Non-infested}} \times 100$;

differences with [2] are significant at the 1% level.

[3]Means of 40 samples

[4]Protein (%) = Nitrogen (%) x 6.26

4 Discussion

Significantly reduced canopy heights of mealybug–infested cassava is attributed to stunting effects of the pest on the host, manifested in known leaf bunching and reduced internode symptoms (NANZE et al., 1979). Severe defoliation of infested plants is believed to arise from toxic salivary materials injected into plants by mealybugs, which cause premature leaf senensence, death and leaf fall (LEUSCHNER, 1980).

Cassava is usually harvested at 10 month, and tuber yield reductions at 10 month reported in this study are similar to those of NWANZE (1982) in Zaire. Loss of leaf surface area arising from defoliation may diminish the photosynthetic efficiency and cause a reduction of food reserves in stem and tuber tissues. WILLIAMS and GHAZALI (1969) have shown that yields in cassava are directly affected by the size and efficiency of the photosynthetic canopy.

The reduction in total carbohydrates and metabolizable energy constituents (Table 2) in plants so stressed by defoliation and other pest effects is not unusual. Similar losses in sugars and other assimilates in tissues of insect-damaged plants have been reported (MILES, 1968; WILLIAMS, 1955). The dietary consequences of reduced tuber carbohydrates are obvious. Also, depletion of assimilates in stem tissues may render then unsuitable as propagative materials. OGBUEHI (1981) has reported that preplant cassava stem storage known to dehydrate and diminish carbohydrates in them may cause > 40% yield declines when used as planting materials.

Enhanced protein content of stem and tuber tissues of infested plants (> 88%) as compared with non-infested ones may be due to mealybug-induced defoliation and perhaps other effects of the pest. Topped or defoliated plants are known to accumulate nitrogenous materials in roots (WATSON and PETRIE, 1940), while AYANRU and SHARMA (1984) reported increased HCN content in roots of cassava heavily defoliated by mites and mealybugs. Shifts in the loci of mobilization of nitrogenous materials, among other anabolites, have been traced largely to toxic insect secretions (mainly amino acids and salivary amylase) in the plants, which alter the balance in host growth factors and cause severe growth abnormalities (LEOPOLD, 1964).

Summary

Half of the stands of a clone (TMS 41044) of cassava *(Manihot esculenta* Crantz) planted in field plots in June 1983 were treated at 3-weekly intervals against mealybugs *(Phenacoccus manihoti* Mat-Ferr.), using Folithion 200 (Fenitrothion). At 10 mo, sprayed and non-sprayed plants were evaluated for mealybug infestations, canopy height and stem diameter, and harvested for yields and assessment of quality. Non-sprayed plants were completely defoliated and reduced (23%) in canopy height, while sprayed ones were free from infestation symptoms. Dry stem and tuber yields of infested cassava were reduced significantly (P = 0,01) by 39 and 60%, respectively, as compared with those of non-infested plants. Stem tissues of infested stands were less

succulent than those of non-infested, while the reverse was true for tuber tissues. Stems and tubers of non-defoliated as compared with defoliated cassava were depleted in total carbohydrates (28,41 vrs 19,06% and 70,72 vrs 65,13%, respectively) and metabolizable energy contents (415 vrs 278 and 1033 vrs 951 kcal kg^{-1}, respectively). On the contrary, tissues of infested plants contained enhanced protein contents (> 88%). The dietary and other implications of augmented or depleted assimilates and anabolites in the tissues, and their induction mechanisms are discussed.

5 Zusammenfassung

Die Hälfte der im Juni 1983 in Feldparzellen ausgepflanzten Cassavapflanzen (Klon TMS 41044) wurden im dreiwöchigen Abstand mit Folithion 200 (Fenitrothion) gegen die Schmierlaus *Phenacoccus manihoti* MAT-FERR. behandelt. Nach 10 Monaten wurden bei sämtlichen Pflanzen Schmierlausbefall, Wuchshöhe und Stengelstärke ermittelt, sie wurden dann zur Ertrags- und Qualitätsfeststellung geerntet. Die nicht behandelten Pflanzen waren vollständig entblättert und um 23% kürzer, während die behandelten Pflanzen keine Befallssymptome aufwiesen. Verglichen mit den befallsfreien Pflanzen waren bei den befallenen Pflanzen die Trockengewichte der Stengel und Knollen um 39% bzw. 60% significant verringert (P = 0,01). Das Stengelgewebe der befallenen Pflanzen war weniger saftig als das der nicht befallenen, während das Gegenteil beim Wurzelgewebe festgestellt wurde. Die Stengel und Knollen der nicht entblätterten Pflanzen zeigten im Vergleich zu den entblätterten geringere Gehalte an Kohlenhydraten (28,41% vs 19,06% und 70,72 vs 65,13%) und Stoffwechsel-Energie (415 vs 278 und 1033 vs 951 kcal/kg^{-1}). Dagegen war der Proteingehalt bei den befallenen Pflanzen höher (> 88%). Die diätischen und sonstigen Folgerungen aus den erhöhten oder verringerten Gehalten und ihre Induktionsmechanismen werden diskutiert.

Acknowledgement

I acknowledge with thanks technical assistance received from Messrs S. O. Akapo, T. Mamber and Dr. C. L. Ndiokwere and the use of laboratory facilities in the tissue quality analysis from Professor G. O. Iwu, of the Chemistry Department, University of Benin, Benin City, Nigeria.

References

1. AKINLOSOTU, T.A.; LEUSCHNER, K., 1981: „Outbreak of two new cassava pests *(Mononychellus tanajoa and Phenacoccus manihoti)* in Southern Nigeria". Trop. Pest Management 27, 247-250.

2. ALDER, H.L.; ROESSLER, E.B., 1962: Introduction to probability and statistics, 2nd ed. San Francisco, W. H. Freeman and Co.

3. ANON, 1980: Cassava mealybug *(Phenacoccus manihoti)* Mat-Ferr. recommended control measures. Advisory Bull. No. 4. Umudike, Nigeria, National Root Crop Research Institute.

4. ATU, U.G.; OKEKE, J.E., 1981: „Evaluation of insecticides for control of cassava mealybug *(Phenacoccus manihoti)*". Trop. Pest Management 27 (2), 251-253.

5. AYANRU, D.K.G.; SHARMA, V.C., 1984/85: „Changes in total cyanide content of tissues from cassava plants infested by mites *(Mononychellus tanajoa)* and mealybugs *(Phenacoccus manihoti)*". Agric. Ecosystems Environ. 12, 35-46.

6. BENNETT, F.D.; GREATHEAD, D.J., 1978: „Biological control of Mealybug *Phenacoccus manihoti matile-ferrero*: prospects and necessity". In Proc. cassava Prot. Workshop, Nov. 1977. Cali, Colombia, CIAT.

7. LAMBERT, J.; MUIR, T.A., 1959: Practical chemistry, 1st ed. London, Hernemann Ltd.

8. LEOPOLD, A.C., 1964: Plant growth and development. New York, McGraw-Hill Book Co.

9. LEUSCHNER, K., 1980: „Biology, ecology and control of cassava mealybug and green spider mite". Proc. of the national workshop on new pests of cassava in Nigeria, Ibadan, IITA. pp.33.

10. MILES, P.W., 1968: „Insect secretions in plants". Ann. Rev. Phytopathol. 6 137-164.

11. NWANZE, K.F., 1982: „Relationships between cassava root yields and crop infestations by the mealybug, *Phenacoccus manihoti*". Trop. Pest Management 28 (1) 27-32.

12. NWANZE, K.F.; LEUSCHNER, K.; EZUMAH, H.C., 1979: „The cassava mealybug, *Phenacoccus* sp. in the Republic of Zaire". PANS 25 (2) 125-130.

13. OGBUEHI, S.N., 1981: „A preliminary study on preplant cassava stem storage on tuber yield". J. Root Crops (India) 7 (1-2) 65-66.

14. RAGUSE, C.A.; SMITH, D., 1965: „Carbohydrate content in alfalfa herbage as influenced by methods of drying". J. Agric. Food Chem. 13 306-309.

15. WATSON, R.;PETRIE, A.H.K., 1940: „Physiological ontogeny in the tobacco plant, IV". Australian J. Exptl. Biol. Med. Sci. 18 313-339.

16. WILLIAMS, R.T., 1955: „Redistribution of mineral elements during development". Ann. Rev. Plant Physiol. 6 25-42.

17. WILLIAMS, C.N.; GHAZALI, S.M., 1969: „Growth and productivity of tapioca *(Manihot utilissima)*. 1. leaf characteristics and yield". Exp. Agric. 5 (3) 183-194.

18. VOGEL, A.I., 1975: A text book of quantitative inorganic analysis, 3rd ed. London, Longman.