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MANAGEMENT OF AFRICAN ROOT AND TUBER SCALE USING IMPROVED CASSAVA GENOTYPES AND MINERAL FERTILISERS

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ABSTRACT

The African root and tuber scale (ARTS), *Stictococcus vayssierei* Richard, is an insect species indigenous to Africa, which has recently become an economic pest of cassava (*Manihot esculenta* Crantz) in many parts of the Democratic Republic of the Congo (D R C). This scale infests underground parts of the plants and prevents young plants from tuberising, thus, causing yield losses of up to 100%. In order to evaluate control components that can be combined into an effective strategy for the management of the scale, six improved cassava genotypes were evaluated for resistance against the scale and NPK fertiliser was tested at the recommended rate as a pest control component. The fertiliser application was made as basal dressing and on one improved clone (F100) with a local variety. Results indicated that ARTS infestations were delayed on 'Kinuani', F100 and the local clone, 'Kileba', as no scales were observed on them 6 months after planting (MAP). The sweetest improved genotype, 'Papayi', harboured the highest number (134.8 insects plant^{-1}) of scales. At 9 and 12 (harvest) MAP, all clones were relatively highly infested, except for the bitter genotype, 'Sadisa'. This clone also yielded more than the local clone. Mineral fertiliser application significantly increased scale population density on F100, and plant height on both F100 and the local clone. It did not significantly affect the number of tuberous roots and root yield on either the improved F100 or on 'Kileba'.

Key Words: Democratic Republic of Congo, *Manihot*, *Stictococcus vayssierei*

RÉSUMÉ

La gamme des racines et tubercules Africains, *Stictococus vayssierei* Richard, est une espèce indigène à l'Afrique qui est récemment devenue une peste économique de manioc (*Manihot esculenta* Crantz) dans beaucoup d'endroits de la République Démocratique du Congo (RDC). Cette gamme infecte les parties souterraines des plantes et empêche les jeunes plantes à former les tubercules, causant ainsi des pertes de rendements jusqu'à 100%. En vue d'évaluer les composants de contrôle qui peuvent être combinés dans une stratégie effective pour la gestion de la gamme, six génotypes améliorés de manioc étaient évalués pour la résistance contre la gamme et le fertilisant NPK était testé au taux recommandé comme un composant de désinsectisation. L'application de fertilisant était faite comme engrais fondamental et sur un clone amélioré (F100) avec une variété locale. Les résultats ont indiqué que les infestations de la gamme des racines et tubercules Africains étaient retardées sur ' Kinuani', F100 et le clone local, 'kileba', étant donné qu'aucune gamme n'était observée sur eux 6 mois après plantations (MAP). Le génotype amélioré le plus sucré, 'Papayi', a hébergé le nombre le plus élevé (134,8 insectes plante^{-1}) de gamme. A 9 et 12 mois (récolte) MAP, tous les clones étaient relativement gravement infectés, à l'exception du génotype amère, 'Sadisa'. Ce clone a aussi produit plus que le clone local. L'application de fertilisant minéral a significativement augmenté la densité de population de gamme sur F100 et sur le clone local. Il n'a pas significativement affecté le nombre des racines tubercules et la racine produite sur le F100 amélioré ou sur 'Kilemba'.

Mots Clés: République Démocratique du Congo, *Manihot*, *Stictococus vayssierei*

INTRODUCTION

The African root and tuber scale (ARTS), *Stictococcus vayssierei* Richard, has become an economic pest of cassava (*Manihot esculenta* Crantz) in the Democratic Republic of the Congo (DRC). The insect is an indigenous species of the African inter-tropical forest zone. The species of the *Stictococcus* genus are especially abundant in the Congolese and Guinea forests (Richard, 1971). This species was first observed in Cameroon on cassava in 1969 and was not an important pest then (Richard, 1971). Although it is believed that ARTS has been in the DRC before cassava was introduced into the country in 1611 (Rossel 1987, cited by Carter *et al.*, 1994), its association with this plant species was only reported in 1978 when the insect caused some damage in a few areas of the Bas-Fleuve district, in the southwestern province of Bas-Congo (PRONAM, 1978). However, Lutete *et al.* (1997) reported that by 1995, the scale was causing severe damage to cassava in several areas of the district.

Early scale infestations kill young cassava plants and prevent tuberisation. Moreover, damaged storage roots are shriveled and discolored at the scale feeding points. Root yield losses can be as high as 100%. In Cameroon, Ngeve (1995) found that ARTS infestations are more severe on poor soils and under dry conditions and of reduced fallow periods. Previous studies conducted in the district have indicated that the extension of cassava cultivation and the resulting shortening of the fallow period were found to be major factors for scale outbreaks in DRC (Lema *et al.*, 2000). It was also observed that a private company that ploughs the land and applies chemical fertilisers to grow cassava on a large scale in an infested area did not experience any ARTS infestations or damage.

Cassava is the staple food for over 70% of the Congolese population and an important source of income for both storage roots and leaves, which constitute the most commonly used leafy vegetable. As a consequence of scale infestations, many farmers have abandoned cassava cultivation; cassava production declined substantially and prices of cassava-based food products have increased tremendously in the district (Lema *et al.*, 2000). Experiments were, thus, carried out to test some components such as the reaction of improved cassava clones to the pest, and to NPK fertiliser both of which can be integrated into an effective and environmentally sound control strategy against the scale.

MATERIALS AND METHODS

The experiments were carried out in an ARTS infested field that was cultivated to cassava in two consecutive years, but which was under fallow for one year before the trials were established. The fallow vegetation was cut and burnt when dry and no ridges or mounds were made as it is usually done in the forest zones. Planting was, thus, done on flat land by making holes in which cuttings were placed and buried completely to avoid termite damage.

Plant spacing was 1 m x 1m. Six improved cassava varieties, developed by the National Cassava Programme (PRONAM), and which have been released or are in the process of being released, were evaluated with a local variety, in a randomised complete block design, with three replications. The improved varieties were: Kinuani, F100, Pululu, RAV, Sadisa and Papayi while Kileba, an old improved genotype considered by farmers as a local variety, was used as a check.

Two plants were randomly selected per replication and records were made on scale population densities, number and weight of storage roots. Data were collected at 6, 9 and 12 months after planting (MAP) for population dynamics of the scale on the clones, and at 9 and 12 MAP for other variables. The experiments were carried out during the 1998-1999 and 1999-2000 cropping seasons.

A separate experiment was conducted to ascertain the effect of mineral fertiliser application on ARTS infestations and on plant tuberisation. Application of NPK fertiliser (17-17-17) at the time of planting on F100 and Kileba was done using the recommended rate of 300 kg ha^{-1}. Measurements were made on plant height, number of tuberous roots, fresh root weight, and on scale population densities by selecting randomly two plants from each replication. Data were collected at 9 and 12 months after planting (MAP).

Data were subjected to ANOVA and significant treatment means were separated using Fishers' LSD at 5% level (Steel *et al.*, 1997).

RESULTS AND DISCUSSION

Data in Figure 1 indicate a delayed ARTS infestations on Kinuani, F100 and the local clone Kileba, as no scales were recorded at 6 MAP. At 6 MAP, scale populations were also relatively low on RAV and Sadisa compared with the sweetest genotype, Papayi, which harboured the highest number of scales. The highest scale population was observed at 9 MAP on Kinuani, F100 and RAV, and declined at 12 MAP. In contrast, the population increased from 6 to 12 MAP on Pululu, Papayi and the local Kileba. Sadisa constantly harboured the lowest scale population. These results show differences in the reaction of the genotypes to scale infestations.

Of the six clones evaluated, Papayi, Sadisa and RAV produced significantly more tuberous roots at 12 MAP than the local Kileba (Table 1). Root weight was relatively low, ranging from 0.8 kg plant^{-1} for F100 to 1.6 kg plant^{-1} for Sadisa, while that of Kileba was 0.4 kg plant^{-1}. However, these three genotypes were not utilised by farmers in the district and, thus, not previously exposed to ARTS. Nevertheless, given the relatively low scale populations harboured by Sadisa, this genotype can be recommended in infested areas, while new improved clones are being evaluated.

Table 2 shows that application of chemical fertiliser at the recommended rate on the improved F100 clone significantly ($P<0.05$) increased scale infestations, while the numbers of tuberous roots and root yield were not significantly ($P>0.05$) different. Fertiliser application, however, significantly increased plant height on both clones. This practice does not protect the plants against ARTS damage. Previous studies have indicated various effects of chemical fertilisers on scales and mealybugs. Miller and Kosztarab (1979) reported that N application increased while K reduced scales populations and infestations. In detailed studies involving separate applications of NPK, N and K applications on two improved cassava clones, Lema and Mahungu (1984) found that these nutrients did not significantly affect the postembryonic development and reproduction (fertility) of the cassava mealybug, *Phenacoccus manihoti* Mat.-Ferr. The relatively large variations

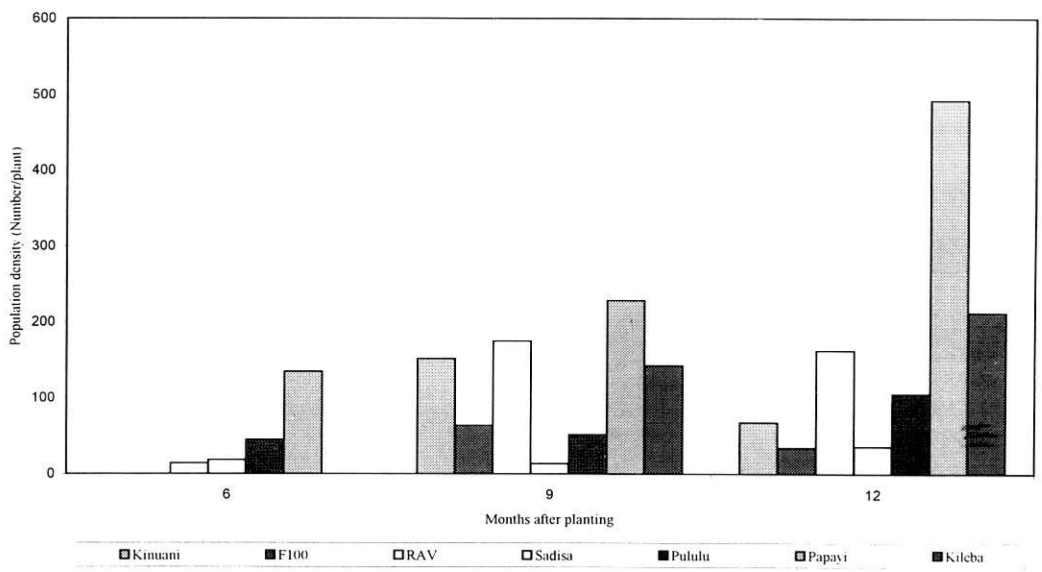

Figure 1. Population dynamics (number plant) of *Stictococcus vayssierei* on six cassava clones in the Democratic Republic of Congo during 1998 - 2000.

TABLE 1. Number (per plant) and weight (kg plant^{-1}) of cassava tuberous roots under root scale infestations, 12 MAP* in DRC during 1998 - 2000 cropping season

Cloness	Number of roots	Root weight	Scales/plant
F100	3.1	0.8	32.6
Kinuani	2.9	0.9	73.1
Pululu	4.1	1.1	67.1
Sadisa	5.8	1.6	22.3
Papayi	6.1	1.0	285.3
RAV	5.7	1.2	117.1
Kileba (local)	3.2	0.4	118.2
LSD (0.05)	1.5	0.6	113.8
CV (%)	39.0	46.5	

* MAP: Months after planting

TABLE 2. Effect of mineral fertiliser on *S. vayssierei* infestations in in DRC during 1998 - 2000 cropping season

Treatment	Scale population /plant	Plant height (cm)	Tuberous roots	Root yield (kg plant^{-1})
F100 + fertiliser	25.3a*	311.3a	4.2a	2.3a
F100 check	8.1b	225.7b	3.8a	1.1a
Local + fertiliser	107.0c	292.3c	7.8b	3.0b
Local check	103.2c	235.3d	6.6b	2.0b

* Means followed by same letter for each clone are not significantly different at $P \leq 0.05$

observed between means for various variables may be due to the relatively small sample size (two plants/replication).

It can be concluded that these improved cassava genotypes, especially Sadisa, can be used to reduce scale infestations and damage. Also, NPK fertiliser application does not constitute an effective component for the management of the ARTS.

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