CATIE
CENTRO AGRONOMICO TROPICAL DE INVESTIGACION Y ENSEÑANZA
Program of Annual Crops

THE PESTS OF SWEET POTATO (*Ipomoea batatas*) AT TURRIALBA, COSTA RICA WITH SPECIAL REFERENCE TO *Polygrammodes elevata* F. (LEP.; PYRALIDAE) AND ITS EFFECT ON YIELD

A.B.S. KING

Third part of the progress report of the entomologist attached to the CATIE cropping systems programme, for the Ministry of Overseas Development of the UK Government.

Turrialba, Costa Rica
1978

KING, A.B.S.* The pests of Sweet Potato (*Ipomoea batatas*) at Turrialba, Costa Rica, with special reference to *Polygrammodes elevata* F. (Lep.; Pyralidae) and its effect on yield** Turrialba, Costa Rica, CATIE 1978. 17p.

SUMMARY

The pests of sweet potato in Costa Rica and their damage are identified. The biology of *Polygrammodes elevata*, an important pest attacking the stems, is described. Infestation of sweet potato, both in monoculture and interplanted with maize, began at the onset of tuberisation, 8-12 weeks after planting and was the same in both systems. Damaged plants produced lower yields. The percent of plants attacked and the severity of stem damage was related to total yield and tuber size. There were significant reductions in yield and a higher proportion of small tubers with increase in percent plants attacked; differences were greatest under conditions favouring high potential yields. The effect of stem damage on yield appeared to be related to the onset of stem rotting, and the time this occurred to affect the final weight of tubers. Insecticides applied at the onset of tuberisation reducedattack and increased yield. Larvae of *P. elevata* are parasited by *Billaea* sp (Tachinidae) and *Oiphosoma* sp. nr. *azteca* (Ichneumonidae). The incidence of tuber damage caused by *P. elevata* and *Rhyssomatus subcostatus* (Curculionidae) was low, but surface feeding by larvae of *Typhorus nigritus* (Chrysomelidae) exceeded 50 percent in weedy plots.

RESUMEN

Se identifica las plagas del camote en Costa Rica y sus daños. Se describe la biología de *Polygrammodes elevata*, una plaga importante que ataca los tallos. La infestación del camote en monocultura y sembrado con maíz comenzó al principio de tuberculización,8 a 12 semanas de la siembra y fue parecido en ambos sistemas. Plantas dañadas produjeron menos tubérculos. El porcentaje de plantas atacadas y la severidad del daño a los tallos fue relacionado con rendimiento total y con el tamaño de los tubérculos. Hubo disminuciones significativas en rendimiento y una proporción más grande de tubérculos pequeños con aumento del porcentaje de plantas atacadas. Este efecto fue más grande bajo condiciones de alto rendimiento potencial. El efecto del daño al tallo pareció estar relacionado con el principio de pudrición y el peso final de los tubérculos con su duración. Insecticidas aplicados al principio de tuberculización redujeron la severidad del ataque y aumentaron el rendimiento. Las larvas de *P. elevata* están parasitados por *Billaea* sp (Tachinidae) y *Oiphosoma* sp. nr. *azteca* (Ichneumonidae). La incidencia del daño a los tubérculos por *P. elevata* y *Rhyssomatus subcostatus* (Curculionidae) fue bajo, pero dañó a las superficies de los tubérculos por larvas de *Typhorus nigritus* (Chrysomelidae) excedieron 50 porciento en parcelas con malezas.

---

* Ph.D., Entomologist, CATIE

** Third part of the progress report of the entomologist attached to the CATIE cropping systems programme for the Ministry of Overseas Development of the UK Government.

CONTENTS

INTRODUCTION

Sweet potato is one of the world's important food crops, (Miller & Hernandez, 1970; Jones, 1970) but is not extensively grown in Central America (Mateo, 1976). However, work at CATIE has shown it to have numerous advantages which would make it eminently suitable for small farmer production. (Mateo, 1976; CATIE, 1977). These are intercropping potential, ease of production with minimal outlay, and the possibility of using both leaves and tubers for human and livestock consumption (Mateo, 1976).

However, there is little information on local pests except on those which also occur in the southern United States and the Caribbean, mainly the tuber mining cuculionids *Rhyssomatus* spp and *Cylas formicarius* (Cockerham and Deen, 1948; Viale and Thomas, 1951; Floyd, 1955 and Borbon, 1964). There are also several species of stem-boring pyralids, of which *Megastes grandalis* is of occasional importance in the Caribbean (Cowland, 1926), but in Central America only *Astura elevata* has been studied, and was found to be of no economic importance. (Borbon, 1964; Zumbado, 1976). At Turrialba, Costa Rica, following several years of trials including sweet potato, the pyralid *Polygrammodes elevata* was found to be common and sometimes causing severe stem damage. Besides the more widespread *Rhyssomatus subcostatus*, various other insects were found attacking all parts of the plant. The identities, importance and damage of these pests were determined, which together with more detailed studies on *P. elevata*, form the major part of this paper.

3. Pests of Sweet Potato and their damage

3.1 Identity of the pests of sweet potato

Four insects species were found tunnelling the stems and tubers of sweet potato at Turrialba. They were identified by the CIE in London as:

1. *Polygrammodes elevata* F. (Lepidoptera, Pyralidae)
2. *Compacta hirtalis* Gn. " "
3. *Megastes* sp.
4. *Rhyssomatus subcostatus* Fahr (Coleoptera; Curculioidae)

Later a 5th species was identified from Honduras:

5. *Stenygra histria* Serv. (Coleoptera; Cerambycidae)

Less serious, but damage potentially important to marketability, was found to be caused by the larvae of *Typhorus nigritus* (F), feeding on the tuber surface causing scarification.

In addition, a wide range of lepidopteran larvae and Cicadellidae feed on the leaves, but seldom cause important damage; major among these is *Spodoptera eridania* Stoll. (Lep. Noctuidae)

Of the above named species *P. elevata* was most common and caused most damage. *R. subcostatus* affected marketability of tubers, but was not generally serious.

3.2 Biology of *Polygrammodes elevata* F.

This small pyralid occurs in overlapping generations throughout the year. The red-colored eggs are laid singly, chiefly on the stems of sweet potato, the female preferring cracks and areas of rough surface close to the soil. Mean fecundity in the laboratory was 190 ($\pm$ 18.3) eggs female; 38% of females produced infertile eggs and 5% no eggs at all.

Mean longevity was 4.4 ± 0.19 days for females and 3.9 ± 0.2 days for males. Mean egg incubation time was 6.7 ± 0.3 days at 26°C. Larvae enter the stem immediately upon hatching through a crack, abrasion, leaf axil or abscission layer. Undamaged tissue produces a gummy exudate in response to wounding which deters or kills young larvae. Larvae become established in the stem at or just below soil level where they cause a cancerous reactive growth. This is a characteristic of attacked plants and is often followed by rotting, which causes weakening or death of the plant. Tubers close to the soil surface may also be mined.

Larvae pass through 4 instars and pupate in a tough cocoon in situ, about 5 weeks after eclosion, however development may be delayed by poor food quality by as much as 10 weeks. The pupal stage lasts for 10-15 days.

3.3 **Distribution of larvae**

P. elevata frequently attacks already damaged or infected stems; this was confirmed by the presence of larvae of all ages in affected stems and a highly aggregated spatial distribution (P of Taylors Power Law = 0.04). Damaged stems are more favoured oviposition sites, allowing easier penetration and more successful development young larvae. This is probably because of lack of exudate and more favourable food provided by undifferentiated wound tissues.

3.4 **Sweet Potato - Sweet Potato + maize Expt. (1975)**

Observation plots (each .01 ha) of sweet potato in monoculture and interplanted with maize in 2 areas were examined for stem attack by *P. elevata* and *Rhyssomatus subcostatus*. Differences in gross and marketable yields from affected and unaffected plants were compared. Both species initially tunnel stems, but later also tubers, especially *R. subcostatus*.

3.4.1 Infestation rate and time

There was no significant difference in percent infestation by *P. elevata* between the two systems at 13 and 17 weeks after planting or at harvest (Table 1). However, in the 13-week sample there was a higher *R. subcostatus* attack in the maiz inter plant, although by 17 weeks the level of attack was the same in both systems. Attack by *P. elevata* began between the 7th and 13 th week after planting, which coincided with the beginning of tuberisation, and remained stable at around 40% until harvest, althought there was a subsequent increase to 77% in the plot which was harvested at 24 weeks (Table 1).

Table 1. Percent sweet potato plants affected by *P. elevata* at harvest in monoculture and interplanted with maize, and overall attack 7 to 24 weeks of the planting.

Crop	Area 1		% plants attacked			Area 2	
Sweet potato	52.3					77.6	
SP. + maize	43.9					76.4	
Weeks after planting:	7	13	16	17	22*	24*	(*Harvest)
Area 1	0	-	41.3	-	49.3	-	
Area 2	-	43.6	-	41.7	-	77.1	

3.4.2 Effect of *P. elevata* on yield (1)

The yields of both total and marketable tubers from plants affected and unaffected by *P. elevata*, were weighed separately and a mean weights per plant calculated. As there was no significant difference in yields between production systems or areas, plot data were combined; yields were compared using students' T test.

There was no significant difference between the gross weights of tubers produced by affected and unaffected plants, (t = 0.995) but that between marketable tubers was significant at 10% (t = 1.98, r = 18). This indicates that the damage caused by *P. elevata* may affect the size of tubers rather than total tuber biomass.

3.5 Damage studies in Sweet Potato I. (1975-76)

3.5.1 Effect of *P. elevata* on yield (2)

The previous experiment indicated that yield, particularly of marketable tubers, was affected by *P. elevata*. An experiment was therefore set up to confirm this and to examine yield loss in greater detail.

Four blocks, each of 5 plots 3m x 3m, were planted with sweet potato in October 1975. Insecticide regimes of 3 levels of severity, untreated plots and population augmentation through infestation with reared larvae were used in an attempt to obtain 5 different levels of damage (= treatments). Plots were harvested after 22 weeks and the gross and marketable weights of tubers from attacked and unattacked plants, and plant numbers determined separately for each plot and its border. Tuber damage by *R. subcostatus* and pyralid larvae was determined later.

Results

Whereas a range of percent attack (treatment means 24.3 to 97.7%) were generated successfully by the treatments, analysis of variance indicated no significant difference in mean weights of marketable tubers per plant between treatment. Because of the high variance within treatments these were rearranged into percentage damage categories and reanalysed (Table 2). The same operation was performed on the treatment border row data.

Analysis of variance of the rearranged data now indicated a significant difference ($p < .05$) between damage categories for marketable tuber but not for gross tuber weights in the plots, and significant differences ($p < .01$) for both gross and marketable tuber weights for treatment borders.

As tuber weight showed a negative correlation with percent damage, regression analyses were performed as the ungrouped plot and border data. Highly significant negative correlations existed between marketable tuber weights and percent damage (Table 3).

Marketable yields was much more strongly affected by attack in the border rows, which also showed higher overall yields, than in the plots themselves. This suggests that under higher yielding conditions, here probably due to reduce plant competition, plants were more sensitive to damage than when the potential yields was lower, here comparable to within plot conditions.

The ratios of marketable to gross tuber weights per plant increased with decreasing attack by *P. elevata* in both situations, supporting evidence that damages causes the production of a higher proportion of small tubers.

Table 2. Mean gross and marketable tuber weights/plant of plots and borders according to damage categories.

Damage categories % plant affected	N°. plots		Mean wt. marketable tubers/plant. (gm)		Mean gross Wt. Tubers/plant (gm)		Ratio of marketable to gross wt.	
	Plots	Borders	Plots	Borders	Plots	Borders	Plots	Borders
100 - 85	7	6	84.4 ± 20.4	93.9 ± 20.5	222 ± 26	270 ± 27	.38	.35
84 - 70	4	5	99.5 ± 27.0	123.9 ± 19.4	256 ± 35	285 ± 29	.39	.43
69 - 50	3	3	154.0 ± 31.2	171.1 ± 14.4	298 ± 40	357 ± 7	.52	.49
< 50	6	6	181.0 ± 22.1	249.8 ± 20.0	317 ± 28	403 ± 15	.57	.62

Table 3. Regression parameters for yield (Mean gm marketable tubers per plant) against percent damage in 20 plots and their borders.

	r	p	Regression equation
Plots	- 0.602	.01	Y = 222.0 - 1.43 x
Borders	- 0.824	.001	Y = 328.0 - 2.54 x

3.5.2 Damage to tubers by *Rhyssomatus subcostatus* - Fahr.

All tubers harvested from the plots were examined for damage by *R. subcostatus*, mining pyralid larvae and other damage and treatments compared (Table 4).

Table 4. Numbers and overall % of tubers damaged by *R. subcostatus* in plots.

N°		Light	medium	severe #	Total tubers	% overall damage
1	Insecticide (7 appls)	10	4	6	252	7.9
2	" (3 appls)	9	8	20	202	13.4
3	" (1 appl)	6	9	15	237	12.6
4	Unsprayed	12	20	16	203	23.6
5	Unsprayed augmented	14	20	24	222	26.1

The same percent of damage occurred to small and large tubers. Damage in border rows was higher but treatment differences were less. This was possibly because of inadequate insecticide coverage and a higher rate of reinfestation.

3.5.3 Damage to tubers by other agents

Damage, often in conjunction with that of *R. subcostatus*, caused by mining larvae of *P. elevata* and *C. hirtalis*, and superficial scarification caused by *Typhorus nigritus* larvae, was also recorded (Table 5, plots and borders combined).

Table 5. Numbers and percent of all tubers affected by *P. elevata* *C. hirtalis*, *T. nigritus*, *R. subcostatus* and rotting.

Treat-ment*	N° tubers	*P. elevata* Tot.	*P. elevata* Addl.	*C. hirtalis* Tot.	*C. hirtalis* Addl.	*T. nigritus* Addl.	Tuber rot Addl.	Sum Addl.	R. sub-costatus	Overall % damage
1	522	7	3	0	0	41	2	46	70	22.2
2	418	12	4	1	0	40	27	71	48	28.5
3	473	18	12	7	4	67	31	114	91	43.3
4	426	15	7	15	3	55	4	69	102	40.1
5	477	40	23	4	2	90	18	133	110	50.9

* For treatments see Table 4.

Whereas *R. subcostatus* was the major cause of tuber damage, and any pyralid damage usually occurred in conjuction with it, a considerable proportion of tubers had superficial damage caused by *T. nigritus*. This and light *R. subcostatus* damage affected only tuber appearance but could affect marketability.

In a high proportion of mind tubers the point of attack was through the stem (80% of attack by Pyralidae and 66% by *R. subcostatus*) or at the point nearest the soil surface.

3.5.4 Emergence from infested haulms and parasitism of *P. elevata*

Haulms affected by *P. elevata* were collected and those from each treatment placed under a separate cage. The total number of adults and parasites emerged during the 52 days after harvest were recored (Table 6).

Table 6. Adult *P. elevata* and parasites emerged from the affected haulms from 5 treatments (march 1976)

Treatment	N° Plants affected	N° adult *P. elevata*	N° *Billaea* sp	N *Oiphosoma* sp	Overall % parasitism
Insecticide (7 appls)	74	28	7	0	20.0
" (3 appls)	100	39	15	1	29.1
" (1 appl)	122	37	12	0	24.5
Untreated	129	163	51	2	24.5
Augmented Nos.	170	82	38	1	32.2

Parasitism by *Billaea* sp (Tachinidae) did not vary much from 25%; that by *Oiphosoma* sp nr azteca (Cresson) was very low.

Larvae and cocoons were also collected from other weet potato experiments from July 1975 to April 1976, and percent parasitism determined (Table 7).

Table 7. Percent parasitism of *P. elevata* larvae collected from July 1975 to April 1976.

	N° *P. elevata*	% *Billaea*	% *Oiphosoma*
July-August'75	493	3.2	4.1
November	121	5.0	4.1
January'76	342	8.2	7.0
April	474	5.9	2.1

The existance of a seasonal cycle of parasitism is indicated; *Billaea* sp. apparently peaking in March and *Oiphosoma* sp. less obiously, in January.

3.6 Damage studies in Sweet Potato II. (1976)

3.6.1 Damage intensity experiment

It was clear from the foregoing experiments that yield loss was related to the percentage of plants attacked by *P. elevata*, however this was an overall assessment which did not consider the extent of individual plant damage. As the intensity of plant damage is obviously related directly to yield loss, this was examined in detail by relating the severity of damage in 900 monitored plants to their yield of tubers. Damage was graded in 6 categories which were well defined in the symptomology of attack, except in small plants which were excluded.

Damage categories:

0 = Free from attack

1 = Slight attack - no stem swelling

2 = Moderate damage: little stem swelling

3 = Severe damage: stem swollen and split

4 = Very severe- stem rotten

5 = Stem severed - death of plant

Approximately 300 plants, in 3 plots 5 x 7 m, inter-planted with beans in January 1976, were examined 13, 16 and 25 (=harvest) weeks after planting, and each placed in one of the above damage categories. The beans had been harvested by week 13. The plots were on intrinsically different fertility, and half of each plot had received four applications of insecticide before assessment, primarily to reduce chrysomelid damage to the beans*

3.6.2 Overall effect on yield and insecticidal control.

The insecticide treatments effectively reduced damage in the treated plot halves with corresponding yield increases (Table 8). Differences in soil fertility, also severely affected yield, probably in part because of higher weed populations in the less fertile plots in which proliferation of the sweet potato canopy coverage was poor or delayed.

Table 8. Mean yields of tubers and levels of infestation by *P. elevata* in sprayed and unsprayed plots.

Plot #	Gross yield /plant (gm)	Yield of large* tubers/plant (gm)	N°plants included	Percent. damaged plants: Categories 2-5	Percent. damaged plants: Categories 4&5 only
A+	336.4	293.9	158	44.3	22.2
A-	261.6	203.4	153	62.7	29.4
B+	266.6	180.7	152	22.4	8.4
B-	96.1	60.1	143	70.0	30.1
C+	146.3	108.4	157	54.8	28.7
C-	91.4	61.3	148	76.4	55.4

(* Large = > 100 gm)
(+ = with insecticide; - = no insecticide)

(* Insecticides: phoxim .1%-4/2; carbaryl .2%-18/2, 1/3, 30/3)
(A top dressing of NPK 10/30/10 was applied to all plots on 10/3, at 300 Kg/ha)

3.6.3 Damage intensity and yield

Plant damage ratings or the whole season were obtained by summation of the damage values given on the 3 occasions, giving overall values ranging from 0 to 15. The mean yields per plant of gross and marketable (more than 100 gm) tubers were calculated for each category and plotted separately for each plot (Figs. 1-3).

P. elevata damage had the greatest impact on tuber yield in the plot with the highest potential yield (A), as indicated in the previous experiments. In this plot there was a damage threshold of around 6. This was approximately equivalent to the presence of 'severe stem damage' by harvest time or moderate damage for about half the duration of the crop.

In the less fertile plots (B + C) having a lower potential yield, the threshold was less pronounced, but an approximately similar grade of damage was reached before a definite decline in yield became apparent. However, in B there was also a pronounced decline after grade 2, indicating possibly a greater sensitivity to attack under marginal soil fertility.

The increasing proportion of small tubers with level of damage shown in the previous experiments was hardly evident in this trial.

3.6.4 Tuber quality and *Typhorus nigritus* attack.

All tubers over 100 g were examined for the presence of two basic types of damage; superficial scarification by *Typhorus nigritus* and mining by *Rhyssomatus subcostatus* and *P. elevata*. *Typhorus* damage was classified into 3 levels ranging from undamaged to complete surface destruction (Table 9).

Table 9. Damage of large tubers by *T. nigritus*, *R. subcostatus* and *P. elevata* in 3 plots of sweet potato.

Plots	Total large tubers	Undamaged	% Tubers damaged by *T. nigritus* slight-medium	severe	% Tubers damaged by: *R. subcostatus*	*P. elevata*
A	379	34.8	50.1	7.7	0.2	0.4
B	284	35.2	39.4	19.7	0.2	0.4
C	173	5.8	30.6	56.6	0.2	0.4

The severity of *Typhorus* damage was inversely related to tuber yield and positively to stem damage by *P. elevata*. Differencies in the severity of damage was probably related to oviposition conditions favorable to the adult beetles; most occured where crop development was poor and where there was substantial weed growth and/or exposed soil. Damage by *R. subcostatus* and *P. elevata* was equally low overall.

3.7 Discussion

The effect of pyralid stem borers on the yield of sweet potato is a subject of some controversy. Studies by Borbón (1964) and Zumabado (1967) on *Astura elevalis* Gn. both indicated a positive correlation of damage with tuber yield, statistically significant in one case. Observations at CATIE, Turrialba indicated no correlation between infestation by *Polygrammodes elevata* and tuber yield (personal communication, M. Mateo, R. Moreno). By contrast, the author's studies unequivocally demonstrated a loss in overall yield, and indicated an adverse effect of tuber size, in response to stem attack by P. *elevata*. There is however agreement on th time of attack - i.e. from the onset of tuberisation and on the fact that few tubers are attacked unless the crop remains in the field unlifted after 5 months from planting, and that tuber attack in frequently through the stem (Zumbado loc. cit.).

Borbón (loc. cit.) achieved no control with heptachlor at 5 lb ai/ha or with aldrin at 2.5 lb ai/haexcept against soil insects. Based cognisance of the insect's biology the author's applications of carbaryl and phoxim at 0.1% (approx 1 Kg ai/ha) to the stems significantly reduced damage and increased yield.

It is clear that small differences in the behavior of P. *elevata* ensure its greater pest status than A. *elevalis*, although both species do essentially the same damage.

In contrast to pyralid stemborers the control of *Rhyssomatus* spp and other curculionids damaging tubers is better documented, both from the U.S. and Central America (e.g. Cockerham & Deen, 1948; Viale & Thomas, 1951; Floyd, 1955).

The intensity of P. *elevata* damage had the greatest impact on tuber yield in the plot with the highest fertility (= highest potential yield); as also indicated by previous experiments. In this plot there was a damage thresholds of around 6; this being equivalent to the presence of "severe stem" damage by harvest from no damage 6 weeks before, or moderate stem damage during about half of the growing season.

There appears to be a relation of a damage threshold of around 6 with stem rotting. The interruption of the flow of photosynthates to the tubers appears to be largely unaffected until the onset of stem rotting, following stage 3, or the splitting of a swollen stem. This tends to follow the production of exit holes by one or more larvae to allow egress of adults, and encourages to the attack by *P. elevata* and secondary organisms. There is then little to no protective gummosis to control fungal or bacteral infection of the swollen region.

Under some conditions a low incidence of attack may even increase yields (Fig 3; Zumbado loc. cit.) probably through plant compensation giving a relationship of type 5 in Walker (1977).

In the less fertile plots (= low potential yield) the threshold was less pronounced, but an approximately similar stage of damage was reached before a definite decline in yield was apparent. However in B there was also a pronounced decline in yield after grades 2 (Fig. 2). The increasing proportion of small tubers with level of damage shown in the previous experiments, was hardly evident in this trial.

3.8 References

1. BORBON, R.A. 1964. Estudio sobre el control químico de algunos insectos de camote (*Ipomoea batatas* L.). Tesis de Ingeniero Agrónomo, Facultad de Agronomía U.C.R. Costa Rica. 27 p.

2. CATIE. 1977. Memoria Anual 1976-1977. Parte tercera; Informe del departamento de Cultivos y Suelos Tropicales 166 p.

3. COCKERHAM, K.L., DEEN, D.T. 1948. Insecticide tests in field plots for control of the sweet potato weevil, J. econ. Ent. 41(4): 563-565.

4. COWLAND, J.W. 1926. Notes on the Sweet potato Pyralid moth *Megastes grandalis* Guen. Poull. Ent. Res. 16:369-372.

5. FLOYD, E.H. 1955. Control of the sweet potato weevil and several insects attacking roots of sweet potatoes in the field. J. econ. Ent. 48(6), 644-648.

6. JONES, A. 1970. The sweet potato today and tomorrow. In: Proc. Second Int. Symp. on Tropical Root of tuber crops Vol. I; Coll. of Tropic. Agric., Univ. of Hwaii. 3 p.

7. MATEO, N V., 1976. Evaluación de un sistema de producción con maíz (*Zeae mays* L) y camote (*Ipomoea batatas* L.)(L) (LAM).

8. MILLER, J.C. and HERNANDEZ, T.P. 1970. The sweet potato as a world crop and how research has improved its nutritional value. In: Proc. Second Int. Symp. Tropical Root and Tuber Crops. Vol. I; Coll. Tropic. Agric., Univ. of Hawaii. 16 p.

9. VIALE, E., THOMAS, N.E. 1951. Combate del gorgojo del camote *Rhyssomatus* sp Curculionidae. Turrialba 1(5):247-251.

10. WALKER, P.T. 1977. Crop losses: some relationships between yield and infestation. Med. Fac. Landbonw. Rijksuniversitaat., Gent. 42/2, 919-926.

11. ZUMBADO, A.Z. 1967. Rendimiento y calidad, e incidencia de *Astura. elevalis* Gn. y otros insectos en Camote cosechado en varias épocas. Tesis de Ing. Agr. Fac. de Agronomía, U.C.R. Costa Rica. 39 p.

FITO-829-78
18 mayo 1978
AK/mdem