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THE POTENTIAL OF CULTURAL AND CHEMICAL CONTROL PRACTICES FOR ENHANCING PRODUCTIVITY OF BANANA RATOONS

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ABSTRACT

A study of the effect of plant population, fertiliser application, number of suckers retained per stool and desuckering time on the 5th and 6th banana ratoons was conducted on *Kibuzi* (AAA-EA) plantation from October 2000 to December 2002. The plantation had earlier (October 1999 to October 2000) received poor management which resulted in high infestation by weevils and nematodes, small bunches and low yields. The study was accomplished in two experiments. In the first experiment, the original spacings of 2.5x2.5m (1,600 plants ha^{-1}), 3x3m (1,111 plants ha^{-1}) and 3.75x3.75m (711 plants ha^{-1}) were maintained in main plots when the plantation was redesigned into a split plot experiment for each original plot with the sub-plots containing N/K fertilisers applied at the rates of 0/0, 50/100 and 100/200-kg ha^{-1} yr^{-1} in two splits since these nutrients were limiting. Phosphorus was applied as a blanket cover at 75 kg P ha^{-1} yr^{-1}. Three suckers were maintained per stool and extra suckers removed using a hand hoe giving a population of 4800, 3,333 and 2133 plants ha^{-1} at 2.5x2.5m, 3x3m and 3.75x3.75m, respectively. The second experiment originally at a spacing of 3x3 m had a split plot design with 2 and 3 suckers per stool maintained in the main plots and extra suckers removed at time intervals of 1 month, 2 months and 3 months in the sub-plots. Curaterr 5G (carbofuran) and Agro-chlordi (chlorpyrifos/dimethoate mixture) were applied in all the sub-plots at the beginning of both experiments (Oct. 2000) to control banana weevils and nematodes. Results of effect of plant population and fertiliser application showed that in the 5th ratoon, plant population had no significant influence on growth characters of flowering plants but flowering to harvesting duration and yield ha^{-1} significantly ($P < 0.05$) decreased with decrease in plant population. The 6th ratoon had a significant ($P < 0.05$) decrease in growth characters of plant height, flowering to harvesting duration, and a significant ($P < 0.05$) increase in yield components of hands per bunch and finger girth with decrease in plant population. Despite fertiliser application at N50K100 and N100K200, there was a remarkable decline in the 6th ratoon due to toppling and snapping following windy weather. Results of number of suckers retained per stool and desuckering time indicated higher growth parameters in the 5th than the 6th ratoon due to population reduction owing to high mat, weevil and nematode infected plants being vulnerable to wind damage. Unlike the 5th ratoon, the 6th ratoon had significant ($P < 0.05$) decrease in all growth parameters with increase in desuckering time. Better economic benefits were observed from early desuckering and N50K100 treatments in both ratoons. Although curaterr 5G significantly ($P < 0.05$) reduced nematode populations resulting in reduced necrosis index and agro-chlordi insecticide treatment following curaterr 5G treatment effectively eliminated weevils from the ratoons, the plants could not effectively recover their rooting system since the corms had been damaged beyond recovery. Thus, were infestation of banana weevils and nematodes is apparent, it is critical to initiate application of control interventions before the 5th ratoon. Besides, results of the study indicate that its better to establish new plantations rather making efforts to rehabilitate long neglected plantations.

Key Words: Desuckering, fertiliser, *Musa* spp., pests and diseases, plant population

RÉSUMÉ

Une étude de l'effet de la population de plantes, l'application des engrais, le nombre des rejets retenues par plante mère et le temps de l'œilletonnage sur la 5eme et 6eme souche était conduite sur plantation de *Kibuzi* (AAA-EA) à partir d'Octobre 2000 à Décembre 2002. La plantation avait précédemment (Octobre 1999 à Octobre 2000) reçu une mauvaise gestion résultant d'une infestation élevée des charançons et nématodes, des petites grappes et faibles rendements. L'étude était accomplie en deux expériences. Dans la première expérience, les espacement originaux de 2,5 x 2,5 m (1600 plantes ha^{-1}), 3 x 3 m (1111plantes ha^{-1}) et 3,75 x 3,75 m (711 plantes ha^{-1}) étaient maintenus dans les parcelles principales lorsque la plantation était redessinée en parcelle expérimentale divisée pour chaque parcelle originale avec des sous parcelles contenant les fertilisants N/K appliqués aux taux de 0/0, 50/100 et 100/200 kg ha^{-1} $annee^{-1}$ en deux fentes parce que ces substances nutritives étaient limitées. Le phosphore était appliqué comme couverture à 75 kg P ha^{-1} $annee^{-1}$. Trois rejets étaient maintenus par plante mère et des rejets de surplus enlevés en utilisant une houe manuelle donnant une population de 4800, 3333 et 2133 plantes ha^{-1} à 2,5 x 2,5 m, 3 x 3 m et 3,75 x 3,75 m respectivement. La seconde expérience originalement à espacement de 3 x 3 m avait un dessin de parcelle divisée avec 2 à 3 rejets par plante mère maintenu dans les parcelles principales et les rejets de surplus enlevés à l'intervalle de temps de 1 mois, 2 mois et 3 mois dans les sous parcelles. Le curateur 5G (carbofuran) et l'Agro-chlordi (mélange chlorpyrifos/dimethoate) étaient appliqués dans toutes les sous parcelles au début de toutes les deux expériences (octobre 2000) pour contrôler les charançons et nématodes dans le champs de banane. Les résultats de l'effet de la population de plantes et l'application de fertilisant ont montré que pour la cinquième souche, la population de plantes avait une influence non significative sur le caractères de croissance de floraison de plantes mais la floraison à la durée de moisson et le rendement ha-1 ont significativement diminué (P<0,05) avec la diminution en population des plantes. La sixième souche avait une décroissance significative (P<0,05) en caractère de croissance de hauteur de plante, la floraison à la durée de la moisson, et une augmentation significative (P<0,05) en composantes de rendement de mains de régime et circonférence de doigt avec la diminution en population des plantes. En dépit de l'application de fertilisant à N50K100 et N100K200, il y avait un déclin remarquable pour la sixième souche à cause du basculement et claquement après un vent. Les résultats de nombre des rejets retenus par plante mère et le temps de l'œilletonnage ont indiqué de paramètres de croissance élevés pour la cinquième que la sixième souche à cause de la réduction de la population suite à une carpette élevée, et au fait que les plantes infectées aux charançons et nématodes sont vulnérables au vent. Contrairement à la cinquième souche, la sixième souche a eu tous les paramètres de croissance significativement réduits, avec l' augmentation dans le temps d'œilletonnage. Les meilleurs bénéfices économiques étaient observés à partir de l'œilletonnage matinal et les traitements N50K100 pour toutes les deux souches. Même si le curateur 5G a réduit significativement (P<0,05) les populations de nématodes résultant dans l'indice de necrosis réduit et le traitement à l'insecticide chlordi après le traitement de curateur 5G a effectivement éliminé les charançons de souches, les plantes ne pourront pas effectivement recouvrir leur système des racines dès lors les cormes ont été endommagées au delà du stade de recouvrement. Ainsi, là où l'infestation de charancons et nématodes de banane est apparente, il est critique d'initier l'application d'intervention de contrôle avant la cinquième souche. En plus, les résultats de l'étude indiquent qu'il est meilleur d'établir des nouvelles plantations que de fournir des efforts pour réhabiliter des plantations longuement négligées.

Mots Clés: Oeilletonnage, fertilisant, *Musa* spp., pestes et maladies, population des plantes

INTRODUCTION

Despite the importance of bananas in Uganda, yields have dropped from about 8.4 tons ha^{-1} in 1970 to 5.9 tons ha^{-1} in 2000 (MAAIF, 2001) yet a potential of 30-35 tons ha^{-1} and 15-25 ha^{-1} exists for commercial and resource poor farmers, respectively (Sys *et al.*, 1993). The decline in banana yield and short life of plantations (about 5 years) in central Uganda has been attributed largely to poor agronomic practices, drought stress, declining soil fertility, pests and diseases (Anon., 1994; Bananuka and Rubaihayo, 1994; Gold *et al.*, 1999; Tenywa *et al.*, 1999). Intra-mat competition and decline in soil fertility increase progressively as plantation progresses to later ratoons. Studies carried out by Odeke *et al.* (1999) on the plant crop indicated no significant effect of plant population on crop growth and yield. According to Lichtemberg *et al.* (1996), there tends to be a decrease in bunch mass and hands per bunch with increasing density from the

2nd ratoon. However, even when plant density is optimum, fertility has to be restored by external application of fertilisers since nutrients are lost in harvested fruits.

In central Uganda, use of inorganic fertiliser for soil fertility enhancement is hardly practiced (Zake *et al.*, 2000) with only 2% of banana farmers using chemical fertilisers (Ngambeki *et al.*, 1992). Among the reasons for the low use of fertilisers is the absence of convincing research results demonstrating profitable banana yield response to fertiliser application.

Desuckering is one of the most important agronomic practices in bananas considering its potential to reduce intra-mat competition and conserve homogeneity of plant layout in the field (Anon., 1997). However, it is also one of the most neglected aspects in resource-limited farmers' fields (Bananuka and Rubaihayo, 1994). As a result, competition effects for moisture, soil nutrients and photosynthates become pronounced especially in ratoons leading to small bunch sizes (Robinson and Nel, 1990; Robinson, 1996). The small bunches (< 16 kg) go for a lower price compared to medium sized bunches (16-22 kg) and large sized bunches (> 22 kg) (Mugisha and Ngambeki, 1995). Earlier studies indicated that inter and intra-mat competition tends to be significant in the ratoon crops necessitating removal of excess suckers for reasonable bunch size production (Odeke *et al.*, 1999). Excess suckers can be removed early at a height of 300 mm for better yields (Robinson and Nel, 1990; Odeke *et al.* 1999). The main objective of this study was, therefore, to establish whether agronomic practices (such as fertiliser application, plant population, number of suckers retained per stool and desuckering time) and chemical applications against pests would improve productivity of ratoon crops.

MATERIALS AND METHODS

The study was carried out at Makerere University Agricultural Research Institute Kabanyolo (MUARIK) which is in central Uganda, located 0° 28'N, 32° 37'E and 1,150 m above sea level. The area has deep red tropical soils (ferralsols) with a pH of 5.0-6.0 (Tumuhairwe and Isabirye, 1993) and a bimodal mean annual rainfall of 1300 mm (Arnold, 1993) characteristic of the Lake Victoria crescent area.

In the first experiment, the established plantation of cultivar *Kibuzi* (AAA-EA) originally planted at spacings of 2.5x2.5m (1,600 plants ha^{-1}), 3x3m (1,111 plants ha^{-1}) and 3.75x3.75m (711 plants ha^{-1}) in October 1997 (Odeke *et al.*, 1999) with plot size of 45 x 15m and three replications was used. The plantation was redesigned in a split plot design with sub-plot sizes of 15x15m containing the fertiliser rates. Nitrogen and potassium supplied by urea and muriate of potash (MOP) were applied in two splits at a six-monthly interval beginning Oct. 2000 at 0/0 (N0K0), 50/100 (N50K100) and 100/200 (N100K200)-kg ha^{-1} yr^{-1} around each mat (60 cm radius) by hand and then incorporated into the soil using a hand hoe. Triple Super Phosphate (TSP) granular form was applied as a blanket cover in a single application to provide phosphorus at a rate of 75 kg P ha^{-1} yr^{-1}. Population control of the ratoons was achieved by maintaining three suckers: a mother plant, a follower and a sword sucker of at least 50cm height per stool and removing the extra suckers using a hand hoe (Odeke *et al.*, 1999) giving a maximum population of 4,800, 3,333 and 2,133 plants ha^{-1}, respectively.

In the second experiment, cultivar *Kibuzi* which had been planted at a standard spacing of 3x3m in Oct. 1997 with 3 replicates was redesigned into a split plot design with number of suckers retained per stool in main plots and desuckering time in sub-plots. The dimensions of the main plots and sub plots were 27x9m and 9x9m, respectively. Two and three suckers per stool were maintained in the main plots and extra suckers were removed at time intervals of 1 month, 2 months and 3 months from the sub-plots by severing them from their mother suckers using a hand hoe. Nitrogen (N), phosphorus (P) and potassium (K) were applied as Urea, TSP and MOP fertilisers, respectively at a rate of 100 kg N ha^{-1}, 75 kg P ha^{-1} and 200 kg K ha^{-1} once a year.

In both experimental sites, soil analysis and classification using the USDA classification system (Okalebo *et al.*, 1993) was done in October 2000 and October 2001. Curaterr 5G (broad spectrum systemic insecticide-nematicide) containing 5% w/w carbofuran was applied 30 cm around each stool at a rate of 60 g at the time of applying fertiliser treatments to control banana weevils and nematodes. Agro-chlordi 500 EC systemic organophosphorus insecticide containing 273 g/l chlorpyrifos and 222 g/l of dimethoate was additionally sprayed at 2-weekly intervals for a period of 3 months in the plots treated with curaterr 5G beginning October 2001 at a rate of 1 litre ha^{-1} to ensure effective control of banana weevils. Data on weevil and nematode populations before and after chemical applications, growth parameters of plant height, plant girth at 100 cm, number of functional leaves and flowering to harvesting duration were collected and recorded. Data on yield and yield components of bunch weight, hands per bunch, finger length, finger girth and fingers per bunch were also collected and recorded. Standard procedures described in earlier studies were followed to collect all the data required (Gowen and Quénéhervé, 1990; Odeke *et al.*, 1999). All data were subjected to analysis of variance using Genstat Statistical Package and where significant differences were detected between treatments, means were separated using LSD tests at 5% probability level (Steel *et al.*, 1997).

RESULTS AND DISCUSSION

The results of soil nutrient analysis in both experiments are presented in Table 1 and showed that the experimental area had a sandy clay loam textural class. The soil contained below the critical banana requirements of total nitrogen, available phosphorus and exchangeable potassium (Okalebo *et al.*, 1993). The second soil nutrient analysis (Oct. 2001) showed that the essential nutrients of N, P and K added in Oct. 2000 had again fallen below the critical values and needed topping up.

TABLE 1. Soil nutrient analysis results at the beginning and end of experiments

Experiments	Element	October 2000			October 2001			*Critical values
		0-15 cm	15-30 cm	**Mean**	0-15 cm	15-30 cm	**Mean**	
Experiment 1	Available P (ppm)	1.4	1.24	**1.32**	18.8	4.7	**11.8**	≥15.0
	Total Nitrogen (%)	0.09	0.09	**0.09**	0.17	0.16	**0.11**	≥0.20
	Exchangeable K (cmol.kg^{-1})	0.36	0.11	**0.24**	0.68	0.04	**0.36**	≥0.44
	Sodium (cmol.kg^{-1})	0.04	0.03	**0.04**	0.05	0.02	**0.04**	<1.00
	Magnesium (cmol.kg^{-1})	3.35	2.97	**3.16**	2.2	1.74	**1.97**	≥0.50
	Calcium (cmol.kg^{-1})	8.06	8.66	**8.36**	6.7	5.40	**6.05**	≥4.00
	Organic matter (%)	2.89	2.30	**2.60**	2.95	2.89	**2.92**	≥3.00
	Soil pH	5.3	5.4	**5.4**	5.45	5.39	**5.4**	≥5.20
	Texture							
	% Sand	42.2	38.8	**40.5**	42.6	42.2	**42.2**	
	% Clay	32.1	34.7	**33.4**	32.6	32.8	**32.7**	
	% Silt	25.8	26.5	**26.2**		25.4	**24.6**	25.0
Experiment 2	Available P (ppm)	2.88	2.24	**2.56**	21.0	4.88	**12.9**	≥15.0
	Total Nitrogen (%)	0.09	0.09	**0.09**	0.18	0.16	**0.17**	≥0.20
	Exchangeable K (cmol.kg^{-1})	0.43	0.33	**0.38**	1.04	0.24	**0.64**	≥0.44
	Sodium (cmol.kg^{-1})	0.05	0.03	**0.04**	0.04	0.02	**0.03**	<1.00
	Magnesium (cmol.kg^{-1})	3.37	3.32	**3.35**	2.38	1.85	**2.12**	≥0.50
	Calcium (cmol.kg^{-1})	8.05	8.10	**8.08**	7.03	5.9	**6.47**	≥4.00
	Organic matter (%)	3.19	2.81	**3.00**	3.14	2.54	**2.84**	≥3.00
	Soil pH	5.8	5.8	**5.8**	5.72	5.7	**5.71**	≥5.20
	Texture							
	% Sand	47.2	42.3	**44.8**	43.3	43.2	**43.3**	
	% Clay	30.1	34.6	**32.4**	34.0	30.8	**32.4**	
	% Silt	22.7	22.6	**22.7**	22.6	23.4	**23.0**	

*Critical values for banana nutritional requirements (Okalebo *et al.*, 1993)

Curaterr 5G significantly ($P < 0.05$) reduced weevil populations in most of the banana plots in both experiments (Tables 2 and 3) but failed to eliminate them necessitating an additional use of agrochlordi insecticide to completely eliminate them. Similarly, although necrosis index significantly ($P < 0.05$) reduced with curaterr 5G application in most of the banana plots, nematode species *Radopholus similis* which was the most predominant in both experiments could still be recorded a year after curaterr 5G had been applied at a six monthly interval. Persistence of *R. similis* could be attributed to the fact that all factors suitable for vigorous plant growth favour multiplication of this pest (Gowen and Queneherve, 1990). *Pratylenchus goodeyi* (absent in the first experimental field) and *Meloidogyne* spp., which were actually few at start, were eliminated by curaterr 5G application and *Helicotylenchus multicinctus* could only be observed in reduced numbers under 1,600 plants ha^{-1} probably due to the more cool microhabitats under the dense canopy (Rukazambuga *et al.*, 1994).

Results from the first experiment indicated that enhanced management did not exhibit significant influence on growth parameters by plant population in the 5th ratoon at flowering stage (Table 4). However, flowering to harvesting duration significantly ($P < 0.05$) decreased with decrease in plant population indicating lesser competition for assimilates associated with lower plant population hence early bunch development cycle (Lichtemberg *et al.*, 1996). Most growth and yield characters had a non-significant response in the 5th ratoon clearly indicating that it probably takes more than the experimental time of this study to achieve rehabilitation in terms of morphological and phenological stability of a ratoon crop. This is in agreement with earlier findings (Robinson and Nel, 1989). In the 6th ratoon, plant height and flowering to harvesting duration significantly ($P < 0.05$) decreased with decrease in plant population. Among the yield characters, number of hands per bunch and finger girth significantly ($P < 0.05$) increased with decrease in plant population as a result of the lesser competition for assimilates which prevails at low plant populations.

Fertiliser application significantly ($P < 0.05$) increased growth parameters in both ratoons at flowering stage as expected (Table 5) indicating the critical importance of potassium and nitrogen for banana growth. Mackeroon and Waister (1985) associated increase in growth parameters with increase in soluble amino compounds and proteins as a result of fertiliser application. Similar increases in growth as a result of fertiliser application have been reported by Hedge (1988) and Robinson (1996). However, despite fertiliser application, growth characters were below those obtained by Odeke *et al.* (1999) especially in the 6th ratoon as a consequence of the effect of initial damage of the root system by nematodes, the corms by weevils and the leaves by black sigatoka epidemic during the growth periods leading to less well developed plants. Flowering to harvesting duration significantly ($P < 0.05$) decreased with increase in fertiliser rates in both ratoons as expected since fertiliser application increases leaf numbers, which encourages flower initiation and fast bunch development (Robinson and Nel, 1989). Yield components and yield ha^{-1} were significantly ($P < 0.05$) increased by fertiliser application in both ratoon crops (Table 5) but a decline in the 6th ratoon was demonstrated due to toppling and snapping resulting from the poor root system and weakened corms due to earlier attack by nematodes and weevils, respectively.

Second experiment results are presented in Table 6. The 5th ratoon had significant ($P < 0.05$) decrease in pseudostem girth at 100 cm with increase in desuckering time due to increased intra-mat competition (Stover and Simmonds, 1987). Likewise, the 6th ratoon had significant ($P < 0.05$) decrease in all growth parameters with increase in desuckering time. The low growth rates where desuckering was delayed was attributed to existence of many suckers hence a drain of assimilates from the parent plant to the daughter suckers (Robinson, 1996).

Flowering to harvesting duration significantly ($P < 0.05$) increased with increase in desuckering time in the ratoon crops (Table 6). The low flowering to harvesting duration at early desuckering (1 month) compared to delayed desuckering (3 months) in the ratoon crops was attributed to reduced competition for water and

TABLE 2. Influence of plant population, fertiliser and chemical (curaterr 5G and agro-chlordi) applications on weevils, nematode populations and their damage (necrosis index)

	1,600 plants ha^{-1}			LSD (0.05)	1,111plants ha^{-1}			LSD (0.05)	711 plants ha $^{-1}$			LSD (0.05)
	NOKO	N50K100	N100K200		NOKO	N50K100	N100K200		NOKO	N50K100	N100K200	
Weevils												
Before treat (Oct. 00)	10	8.9	8.8	ns	9.1	8.6	8.8	ns	8.6	8.2	7.9	ns
*6 months after treat 1	5.2	5.0	4.4	ns	3.6	3.3	4.1	ns	4.1	2.2	4.1	ns
*6 months after treat. 2	3.7	3.4	2.2	ns	2.4	2.0	2.7	ns	2.9	0.0	3.0	ns
Agrochlordi [1]	0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0	
LSD (0.05)	3.7	3.6	3.6		4.1	2.6	1.8		1.1	N/A	2.9	
Helicotylenchus multicinctus												
Before treatment	333	2056	417	63	302	87	92	22	83	167	208	ns
*6 months after treat. 1	167	292	292	ns	16	0.0	0.0		0.0	0.0	55	
*6 months after treat. 2	42	167	208	ns	0.0	0.0	0.0		0.0	0.0	0.0	
LSD (0.05)	138	156	ns		62	N/A	N/A		N/A	N/A	54.3	
Radopholus similis												
Before treatment	914	1222	2278	ns	667	917	1417	56	1000	2083	4167	ns
*6 months after treat. 1	833	610	1111	ns	333	611	542	ns	339	444	610	ns
*6 months after treat. 2	203	108	117	ns	250	335	292	ns	103	335	358	5.5
LSD (0.05)	64	109	131		170	212	597		208	213	318	
***Meloidogyne* spp.**												
Before treatment	1000	56	111	21	1333	250	83	36	417	167	333	ns
*6 months after treat. 1	0.0	42	0.0		83	42	0.0	ns	0.0	0.0	0.0	
*6 months after treat. 2	0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0	
LSD (0.05)	N/A	46.3	N/A		638.7	ns	N/A		N/A	N/A	N/A	
Necrosis index (%)												
Before treatment	3.3	2.2	8	ns	5.0	11.3	3.2	ns	2.7	6.1	4.5	ns
*6 months after treat. 1	3.0	1.3	6.6	2.2	5.6	5.6	2.9	ns	0.7	1.0	1.7	ns
*6 months after treat. 2	2.8	1.2	6.2	ns	3.0	2.1	1.7	ns	1.2	0.8	1.4	ns
LSD (0.05)	ns	0.7	ns		0.7	1.8	ns		0.8	1.3	1.6	

Nematode populations are estimates of 100g fresh root weight. Agrochlordi [1] : Applied to control weevils only and data taken following similar trend (six monthly interval). * = treatment with curaterr 5G, N/A = Not applicable nutrients leading to increased growth rate (Robinson and Nel, 1986). Robinson (1996) reported extended cycle duration as a result of maintaining unwanted suckers in a plantation which tend to reduce transmission of radiation. A non-consistent trend in most yield components and yield per hectare was observed with desuckering time in the ratoons, which was attributed to the damaged root system by the nematodes and corm by the weevils, which reduced the system's ability to absorb nutrients and water from the soil. In both experiments, however, the ratoon crop in the 6th cycle showed signs of recovery from the nematode and weevil attack as differences started to appear among treatments.

Cost-benefit analysis for the different fertiliser rates indicated better net returns at N50K100 (U. Shs 261,479) than at N100/K200 (U. Shs 109,002)

TABLE 3. Influence of number of suckers retained per stool and desuckering time on weevils, nematode populations and necrosis index at 6 months treatment intervals with curaterr 5G and agro-chlordi

	2 suckers retained per stool			3 suckers retained per stool		
	1 month	2 months	3 months	1 month	2 months	3 months
Weevil population						
Before treat (Oct. 00)	7.6	9.6	6.0	10.0	10.4	9.1
*6 months after treat.1	2.6	4.1	4.1	3.0	5.6	8.3
*6 months after treat. 2	0.2	3.5	3.0	2.7	4.2	6.6
Agrochlordi treat.	0.0	0.0	0.0	0.0	0.0	0.0
LSD $_{(0.05)}$	1.1	3.6	3.0	3.9	1.7	1.5
Pratylenchus goodeyi						
Before treat	278	56	49	278	66	89
*6 months after treat. 1	7.4	6.7	0.0	0.0	5.8	0.0
*6 months after treat. 2	0.0	0.0	0.0	0.0	0.0	0.0
LSD $_{(0.05)}$	18.2	43.4	N/A	N/A	16.1	N/A
Radopholus similis						
Before treat	1056	500	1111	833	278	278
*6 months after treat. 1	667	333	917	292	83	208
*6 months after treat. 2	83	167	667	8.4	56	167
LSD $_{(0.05)}$	447.5	121.3	140.5	236.9	83.5	ns
Before treat	83	9.0	23	83	3.6	101
*6 months after treat. 1	0.0	0.0	0.0	0.0	0.0	0.0
*6 months after treat. 2	0.0	0.0	0.0	0.0	0.0	0.0
LSD $_{(0.05)}$	N/A	N/A	N/A	N/A	N/A	N/A
***Meloidogyne* spp.**						
Before treat	4.8	0.8	2.4	15.2	10.6	18.4
*6 months after treat. 1	0.0	0.0	0.0	0.0	4.8	8.3
*6 months after treat. 2	0.0	0.0	0.0	0.0	0.0	0.0
LSD $_{(0.05)}$	N/A	N/A	N/A	N/A	4.7	5.8
Necrosis index (%)						
Before treat	0.9	6.0	5.7	3.3	2.0	4.5
6 mths after treat. 1	0.5	1.6	4.2	1.6	1.8	1.6
6 months aft treat. 2	0.0	0.7	3.3	1.2	1.3	1.3
LSD $_{(0.05)}$	ns	0.9	1.5	1.1	ns	1.3

LSD $_{(0.05)}$ = not significant across treatments, * = treatment with curaterr 5G, N/A = Not applicable

TABLE 4. Effect of plant population on growth parameters of 5th and 6th banana ratoon crops at flowering stage and yield and yield components

Plant population (ha^{-1})	Plant growth characters: Plant height (cm)		Girth at 100 cm		No. of functional leaves		Flowering to harvesting duration		Yield characters: Bunch weight (kg)		Hands per bunch		Finger length (cm)		Finger girth (cm)		Fingers per bunch		Yield ($t\ ha^{-1}$)	
	R5	R6	R5	R6	R5	R6	R5	R6	R5	R6	R5	R6	R5	R6	R5	R6	R5	R6	R5	R6
1,600	283	276	43	38	4.3	4.5	112	111	10	8.2	6.7	6.5	16.1	15.1	13.6	12.1	85	78	16	13
1,111	287	259	45	37	4.2	4.1	111	109	11	8.7	7.0	7.1	16.5	14.8	13.7	13.3	92	78	13	9.6
711	273	256	42	38	4.3	4.0	104	103	11	9.7	6.8	7.2	16.2	15.6	13.8	13.7	92	89	8.1	6.9
LSD ($_{0.05}$)	ns	15	ns	ns	ns	ns	6.4	5.7	ns	ns	ns	0.2	ns	ns	ns	0.8	ns	ns	4.0	ns
CV (%)	4.2	2.5	3.7	4.9	4.2	5.8	2.6	4.4	12	19	9.2	1.1	3.2	5.3	3.8	2.6	11	6.8	14	27

TABLE 5. Effect of fertiliser application on growth parameters of 5th and 6th banana ratoon crops at flowering stage and yield and yield components

Fertiliser rate	Plant growth characters: Plant height (cm)		Girth at 100 cm		No. of functional leaves		Flowering to harvesting duration		Yield characters: Bunch weight (kg)		Hands per bunch		Finger length (cm)		Finger girth (cm)		Fingers per bunch		Yield ($t\ ha^{-1}$)	
	R5	R6	R5	R6	R5	R6	R5	R6	R5	R6	R5	R6	R5	R6	R5	R6	R5	R6	R5	R6
N0K0	262	256	41	35	3.7	3.7	117	115	8	5.5	6.2	6.6	15.0	14.1	13	12	77	77	8.7	5.9
N50K100	286	264	43	38	4.4	4.0	108	107	12	10	7.2	7.0	16.9	15.2	14	13	94	82	13.7	11.4
N100K200	294	271	45	39	4.7	4.8	101	102	13	11	7.2	7.2	16.8	16.2	14	14	98	86	14.3	12.4
LSD ($_{0.05}$)	21	8.0	ns	2.4	0.7	0.4	8.0	6.8	3	1.9	0.6	0.2	0.9	0.8	0.6	0.4	14	4	2.6	2.4
CV (%)	6.1	2.5	13	3.2	8.8	15	6.7	8.8	22	30	12	4.7	5.6	5.2	3.6	7.9	10	12	20.3	33.7

R5 = 5th ratoon, R6 = 6th ratoon, ns = not significant at 0.05 probability level

TABLE 6. Effect of number of suckers retained per stool and desuckering time on growth of 5th and 6th banana ratoon crops at flowering stage and yield and yield components

Fertiliser rate	Plant growth characters								Yield characters											
	Plant height (cm)		Girth at 100 cm		No. of functional leaves		Flowering to harvesting duration		Bunch weight (kg)		Hands per bunch		Finger length (cm)		Finger girth (cm)		Fingers per bunch		Yield ($t\ ha^{-1}$)	
	R5	R6	R5	R6	R5	R6	R5	R6	R5	R6	R5	R6	R5	R6	R5	R6	R5	R6	R5	R6
2 suckers																				
1 month	300	279	50	47	4.7	4.9	106	105	18	15	7.7	7.5	18	18	15	15	112	104	20.3	16.5
2 months	271	271	44	41	4.5	4.0	111	107	9.8	7.4	5.9	6.3	17	17	14	14	71	67	10.8	8.3
3 months	270	265	40	40	3.9	3.8	118	115	7.9	6.7	5.7	5.9	16	16	14	14	65	60	8.7	7.4
LSD (0.05)	ns	9.0	6.6	4.4	ns	0.5	7.3	6.6	ns	2.9	1.3	ns	ns	ns	ns	0.7	35	7.3	ns	3.2
3 suckers																				
1 month	295	293	48	41	5.1	5.1	105	108	16	12	7.7	7.3	17	17	15	14	111	100	17.9	13.2
2 months	292	278	46	36	4.9	4.4	109	113	14	8.4	7.5	6.5	18	16	14	14	105	70	15.0	9.3
3 months	283	267	44	34	3.7	3.8	115	115	10	7.0	6.4	6.0	17	16	14	13	81	54	11.1	7.8
LSD (0.05)	ns	16	ns	2.8	ns	0.7	6.5	5.2	ns	2.1	ns	ns	ns	ns	ns	1.0	ns	10	ns	2.4

in the 5th ratoon crop but the 6th ratoon had better net returns at N100K200 than at N50K100 (Table 7). This could be attributed to the fact that the 6th ratoon utilised the applied nutrients right from the peeping stage. The high variable costs in the 5th ratoon compared to the 6th ratoon resulted from rehabilitating the neglected plantation in the 5th ratoon. In the 6th ratoon, only hand weeding was needed. Results of cost-benefit analysis for the three desuckering times are presented in Table 8. Savings were made in the 6th ratoon since curaterr 5G was not applied and weeding was done using mainly the hand hoe, which was less expensive than in the 5th ratoon where both the hand hoe and herbicides were used. Results indicated that early desuckering (1 month) had better net returns. Results of the study, however, indicated that perhaps it is better to start new plantations rather than attempting to rehabilitate long neglected plantations in this area.

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TABLE 7. Cost benefit analysis for fertiliser application to the banana ratoon crops

Item	Fertiliser treatments					
	5th ratoon			6th ratoon		
	N0K0	N50K100	N100K200	N0K0	N50K100	N100K200
Average yield (kg ha^{-1})	8,700	13,700	14,300	5,867	11,367	12,367
Adjusted yield (kg ha^{-1})	8,526	13,426	14,014	5,750	11,140	12,120
Gross sales (U.Sh.)	1,278,900	2,013,900	2,102,100	862,500	1,671,000	1,818,000
Total variable costs (U.Sh. ha^{-1})	1,511,520	1,752,421	1,993,098	651,531	771,981	892,321
Net returns	-232,620	261,479	109,002	210,969	899,019	925,679

A 2% yield loss was used to obtain adjusted yield. Farm gate price of 150 U. Shs per kg was used. 1 US$ = 1750 U. Shs. 1 person day = 1500/=

TABLE 8. Cost benefit analysis for desuckering time treatments for the banana ratoon crops

Item	Desuckering time					
	5th ratoon			6th ratoon		
	1 month	2 months	3 months	1 month	2 months	3 months
Average yield (kg ha^{-1})	19,100	12,900	9,900	14,850	8,750	7,600
Adjusted yield (kg ha^{-1})	18,718	12,642	9,702	14,553	8,575	7,448
Gross sales (U.Sh.)	2,807,700	1,896,300	1,455,300	2,182,950	1,286,250	1,117,200
Total variable costs (U.Sh. ha^{-1})	1,835,833	1,794,539	1,735,897	1,195,961	1,154,667	1,096,025
Net returns	971,867	101,761	-280,597	986,989	131,583	21,175

A 2% yield loss was used to obtain adjusted yield. Farm gate price of 150 U. Shs per kg was used. 1 US$ = 1750 U. Shs. 1 person day = 1500/=

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