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OUTBREAK OF GINGER (*Zingiber officinale* Rosc.) RHIZOME ROT IN THE MAJOR GROWING AREAS OF JAMAICA

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ABSTRACT

In recent years, the domestic and international markets for ginger have grown. In Jamaica, grower interest in this crop has fluctuated with traditional price-induced gluts and shortages. Nevertheless, numerous farmers still rely on ginger as a major seasonal source of income. Since 1995, the major ginger growing areas experienced a rhizome rot whieh has since intensified and spread. This disease complex now presents a major threat to the ginger industry in Jamaiea as present average total damage levels approximate 55%. The pathogens *Fusarium* spp., *Pythium* spp., *Rhizoctonia* spp., *Pseudomonas* spp. and *Verticillium* spp. were isolated from diseased rhizomes. The disease eomplex has adversely affected both exports and local supply, forcing prices up and restricting availability of planting material. An experiment was established to evaluate chemical disease control. Pre-plant fungicide/bacteristatic/baetericide rhizome dips were superior to the untreated control (farmer practice). Results are presented.

INTRODUCTION

Ginger (*Zingiber officinale* Rosc.) was introduced to Jamaica by the Spanish around 1525. It has since been grown ehiefly for export and in 1547, over one million metric tons were exported. By 1740, the crop was being grown in the so-called Christiana mountains of central Jamaica where climatic conditions are particularly suitable for growth (Rodriguez, DW. 1971). These hills became the principal growing area, a position retained until today. The eommodity has played a major role in the economic development of the area up to three decades ago and is still widely grown today.

In reeent years, demand for ginger has grown in the major overseas **(Table 1, Fig. 1)** and local markets. Jamaican peeled, dried ginger has long been regarded as and remains the quality standard worldwide, as reflected in relative prices for the commodity **(Table 2, Fig. 2)**. Local use has grown through the production, of an internationally acclaimed beverage, a wide range of natural fruit juices and other products. This has prompted a 27% increase in area planted since 1995 **(Table 3, Fig. 3)**. Despite the potential for meaningful contribution to those communities, the agricultural sector and national economy, Jamaican ginger is pricing itself out of the international market. In recent years, competitors have been supplying growingly comparable products. The challenge for improved productivity and marketing thus presents itself.

During the crop of 1995, an abnormal incidence of rhizome rot (GRR) was experienced in the parish of Clarendon. Reported pre- and post-harvest losses averaged 10% and 15%, respectively, of total yield.

Symptoms appear on foliage and underground parts of the plant. Leaves of affected plants wilt, curl downwards, become yellow then dried. The collar region weakens, the plant bends, topples and may be easily pulled from the underground portion. Rhizomes exhibit soft or dry rots and abnormal brighter yellow or darker translucent colours. These symptoms seem to be associated with the presence of different causal agents.

The disease is spread in infected planting material and infested soil. The former promotes pre-emergence rotting and reduced sprouting. Post-harvest rotting of apparently healthy rhizomes may occur in storage weeks or months after reaping,.

Several pathogens were isolated from diseased material. These include the fungi *Fusarium oxysporum, F. solani var. coerulum, F.* spp., *Pythium* spp., *Rhizoctonia solani, Verticillium* spp. and the bacterium *Pseudomonas* spp. The saprophytes, *Aspergillus* spp. and *Penicillium* spp. were also isolated.

Reports from India indicate that ginger is affected by several species of *Fusarium spp.* (Dake, 1995, Mathur et al, 1984, Sampath Kumar, 1977, Pandey et al, 1992, Dohroo, 1994, Joshi et al, 1980) causing Ginger Yellows, *Pythium aphanidermatum* and other *Pythium* spp. (Dake 1995, Manomohan Das et al ?, Mathur et al 1984, Sarma et al 1978) causing soft rot and *Pseudomonas solanacearum* (Dake 1995, Manomohan Das et al 1986, Joshi et al 1980, Sarme et al 1978, Indrasenan et al 1981) causing bacterial wilt. *Rhizoctonia* spp. (Ridley 1912), causing dry rot and *Rosellinia* spp. (Leather 1967), Black Rot, have been reported from Jamaica. Plant parasitic nematodes and maggots have also been reported associated with rhizome rot (Ghorpade et al 1982). All these diseases produce a rotting of rhizome tissues, termed ginger rhizome rot (GRR). Several management tactics have been attempted in India, with varying, sub-optimal levels of success. Integrated management is therefore recommended (Dake 1995).

In 1996, an extensive GRR outbreak was observed in the production belt of central Jamaica where four parishes (Clarendon, St. Ann, Manchester, Trelawny) meet. Since then, the disease has also been observed some 60 km to the west in Westmoreland, which received planting material from Clarendon in 1995.

Farmer reports suggest that the disease first appeared around 1993 but the low levels did not arouse concern. Many farmers continued to acquire ginger planting material from infested sources, spreading the disease to other areas and raising infestation levels. At March 1997, average losses reached 30% at harvest with overall pre- and post-harvest farm losses closer to 55% total yield. Extension personnel estimated 240 hectares grown by 1 500 farmers as affected.

This reduced supply has resulted in price increases of fresh rhizomes from J$33/kg in 1996 to J$88/kg today. In the worst affected areas, farmers reap prematurely in an effort to minimize losses from GRR. High levels of post-harvest rot now force farmers to sell the entire harvest as fresh ginger, significantly reducing the supply of planting material as well. Drying ginger increases the risk of losses from the disease. Supply of the dried product has therefore fallen. This has led to reduced export volumes (**Table 4, Fig. 4**) as only dried product is exported.

In 1996, the use of field sanitation, healthy planting material, crop rotation and a fungicide soil drench proved inadequate. In June, 1997, an experimental plot was thus established, to find an effective pre-plant fungicide treatment for planting material (setts).

MATERIALS AND METHODS

The experiment was conducted at Mt. Moriah, St. Ann, in the major ginger growing belt, on the predominant Wirefence clay loam soil type. The plot had been in ruinate fallow for 21 years, grazed periodically by livestock.

Setts were obtained from the farmer's previous harvest which experienced some 30% total GRR. The farmer visually inspected outer and internal tissues, in an effort to exclude diseased material. Setts (ca. 6-10 cm long) comprising one or two nodes with one or more axillary branches were broken from rhizomes and weighed in woven polypropylene bags.

Treatments

Two fungicides and one fungicide/bacteristatic/bactericide were compared with an untreated control (farmer practice), replicated three times in a randomized complete block design. These comprised:

Table 1. Imports of ginger ('000 MT) – (US & UK, 1992-95).

Year	1992	1993	1994	1995	1996
USA	8,240	8,100	14,500	15,300	13,770
EUROPE	12	11	12	13	N.A
TOTAL	**8,252**	**8,111**	**14,512**	**15,313**	

Source : Eurostat June,1998

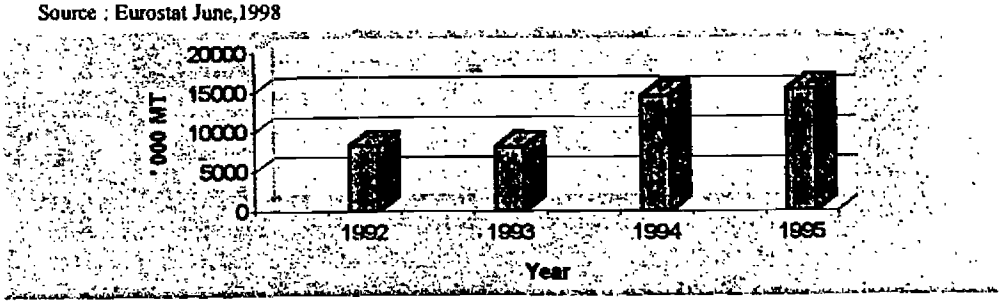

Figure 1. Imports of ginger ('000 MT) – (US 1992-95)

Table 2. Prices of Peeled, Dried, Whole Ginger Rhizomes (C.I.F. United States, 1998).

ORIGIN	China	India	Jamaica
PRICE (US$/MT)	1 800 - 1 920	1 985 - 2 030	8 340

Source : Market News Service, April, 1998, Intl. Trade C. Geneva

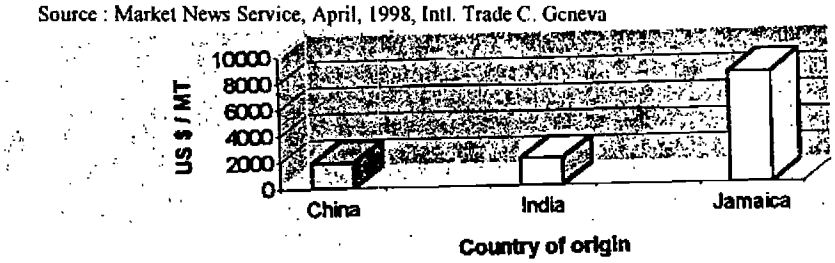

Figure 2. Prices of peeled, dried, whole ginger rhizomes (C.I.F. United States, 1998)

Table 3. Production of ginger - Jamaica (1993-1997).

Year	1993	1994	1995	1996	1997
Area (Ha)	205	207	161	182	204
Volume (T)	731	782	452	617	513
Yield (T/Ha)	3.1	3.8	2.8	3.4	2.5

Source : MinAg Data Bank & Evaluation Division.

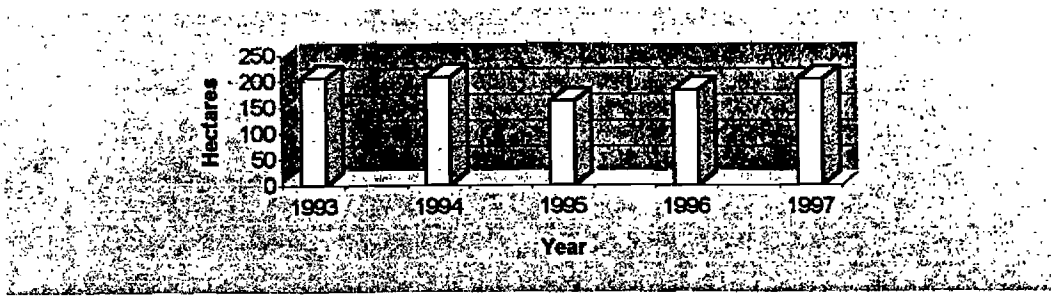

Figure 3. Area of ginger produced - Jamaica, 1993 - 97

Table 4. Peeled, dried ginger exports - Jamaica.

YEAR	1993	1994	1995	1996	1997	1998
VOLUME (MT)	110	100	90	125	125	40
PRICE (J$)	121.00	66.00	110.00	165.00	220	231.00

Source : Pimento Export Division, 1998

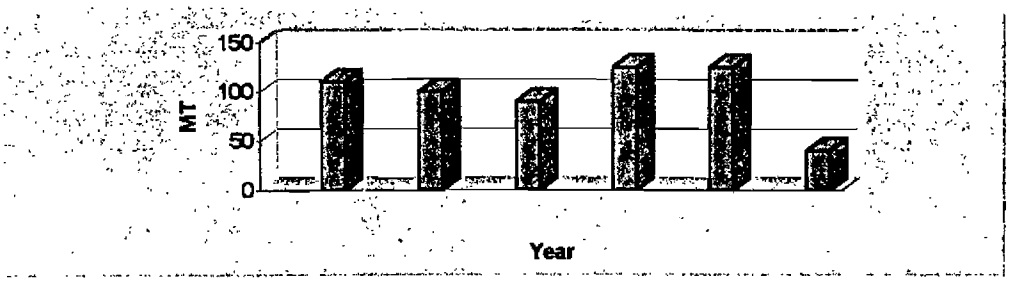

Figure 4. Exports of peeled, dried ginger (MT) - Jamaica, 1993-98

Table 5. Effect of pre-plant fungicide dips on rhizome rot of ginger, Mt. Moriah, St. Ann (Jun-Dec 1997).

Treatments	T	TB	TBR	C	P	SED
Symptoms 106 dap (no. plants)	3.33a	6.68b	3.91a	21.08c	<.001	1.085
152 DAP (no. plants)	1.67a	7.12b	5.57b	10.98c	0.002	1.111
Ground cover 106 DAP (%)	54.7a	58.6a	57.2a	33.8b	0.077	7.89
Marketable yield (Kg/plot)	17.8a	15.9a	15.8a	4.4b	0.077	4.23
Proportion.						
Mktbl : Total Yield	0.91a	0.86a	0.88a	0.54b	0.003	0.055

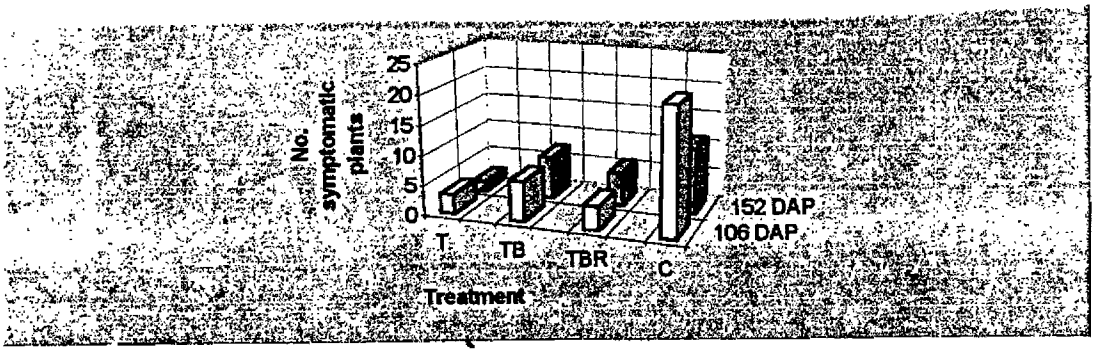

Figure 5. Foliage disease levels, Ginger rhizome rot trial, Mt. Moriah, St. Ann (1/98)

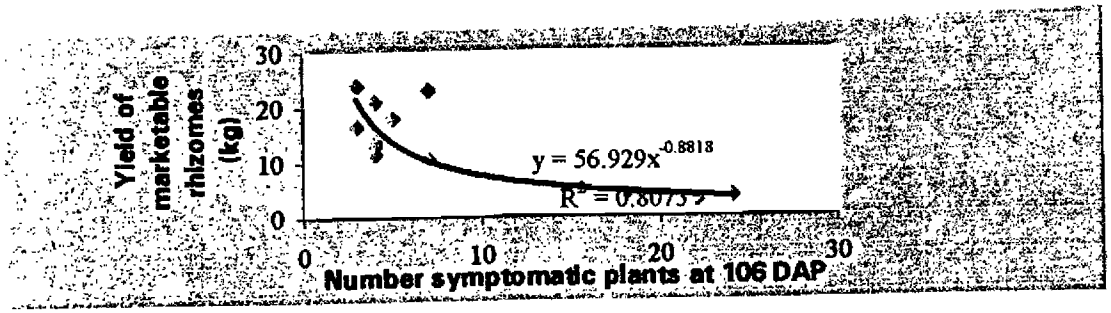

Figure 6. Relationsbip between symptom expression and marketable yield, Ginger rbizome rot trial, Mt. Moriab, St. Ann (1/98)

1. 0.7% Topsin-M (70% thiophanate methyl) (**T**)
2. 0.7% Topsin M + 0.4% Bravo C/M (27% chlorothalonil; 5.4% maneb; 45.8% copper oxychloride) (**TB**)
3. 0.7% Topsin M + 0.4% Bravo C/M + 1.3% Ridomil MZ (8 % metalaxyl; 64% maneb) (**TBR**)
4. No treatment (farmer practice) (**C**)

Chemicals were mixed in 75 L water in a 200 L plastic drum and setts in bags immersed for 20 minutes with periodic (every 2-minutes) agitation.

Plot size/plant population

Setts were drained for 10 to 15 minutes then planted out 3-5 cm deep, at 20 cm intervals in drills 30 cm apart. Plot size was 4m x 3m, giving a plant population of 195 per plot.

Data Recorded

Numbers of emerged sprouts were recorded 45 and 56 days after planting (DAP). Numbers of plants showing disease symptoms (yellowing and wilting of foliage) and estimates of percentage ground covered by ginger foliage were recorded 106 and 152 DAP. Yields were recorded 196 DAP, separating marketable (visibly healthy rhizomes), discoloured (evidently diseased) and rotted material. A composite sample comprising ten rhizomes from each treatment was held in the farmer's storage area to observe for post-harvest rotting.

RESULTS

Emergence

No significant difference was observed between treatments ($p=0.925$ 45 DAP; $p=0.988$ 56 DAP).

Foliage symptoms

At 106 DAP, all chemical treatments gave significantly less foliage symptoms than **C**. **T** and **TBR** were similar and superior to **TB**. ($p<0.001$) (Table 5, Fig. 5)
At 152 DAP, **T** was significantly better than **TB** and **TBR** ($p=0.002$). A strong negative relationship was observed with marketable yield (Table 5, Fig. 6).

Ground Cover

At 106 DAP, all chemical treatments were similarly superior to the control ($p=0.077$) (Table 5, Fig. 7). A strong positive correlation existed between this parameter and marketable yield (**Fig. 8**). At 152 DAP, differences were no longer visible ($p=0.297$).

Yield

All chemical treatments produced similarly significantly higher yields of marketable rhizomes than the control ($p=0.077$) (Table 5, Fig. 9). Treatment **T yielded** the equivalent of 14.8 T/Ha, compared to 3.7 T/Ha for **C**. No significant differences were detected for either rotted ($p=0.205$), unmarketable rhizomes (rotted + discoloured, $p=0.415$) or total yield ($p=0.128$).

Proportion of marketable to total yields ($p=0.003$)(Table 5, **Fig. 10**) showed significant differences between chemical treatments and control. There were no differences between chemical treatments.

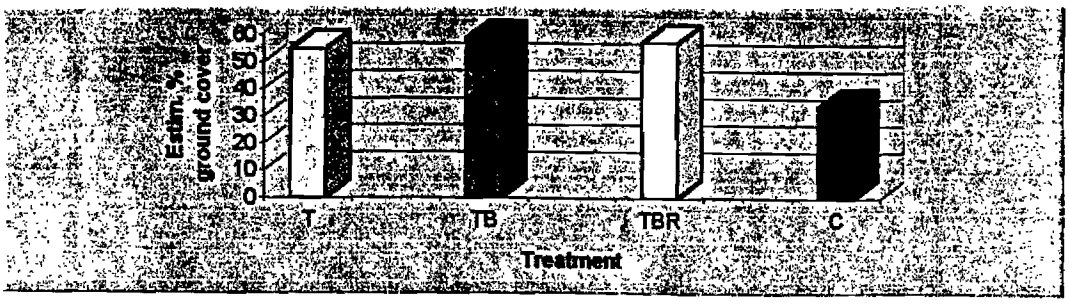

Figure 7. Ground cover - 106 DAP, Ginger rhizome rot trial, Mt. Moriah, St. Ann (1/98)

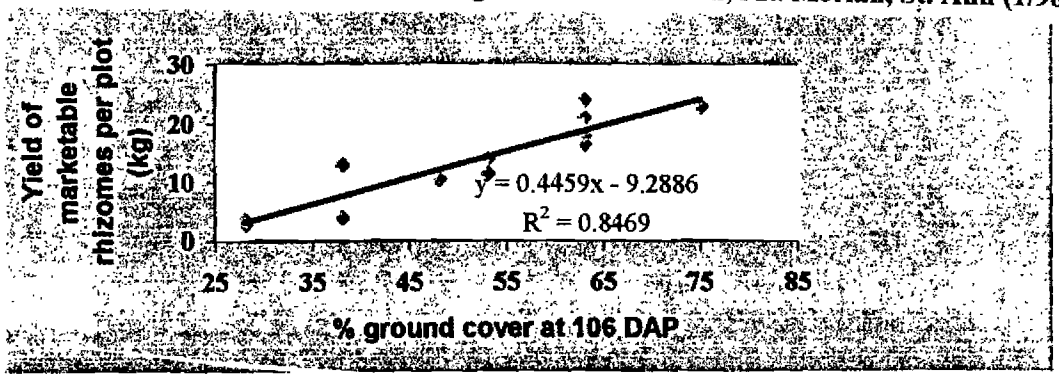

Figure 8. Regression - percentage ground cover on marketable yield, Ginger rhizome rot trial, Mt. Moriah, St. Ann (1/98)

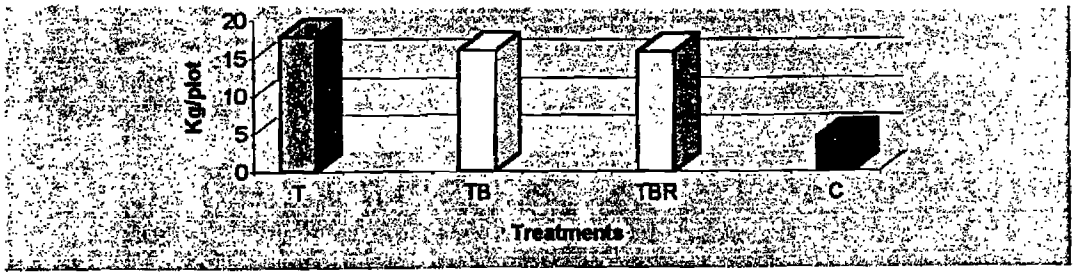

Figure 9. Marketable yield (kg/plot) - Ginger rhizome rot trial, Mt. Moriah, St. Ann (1/98)

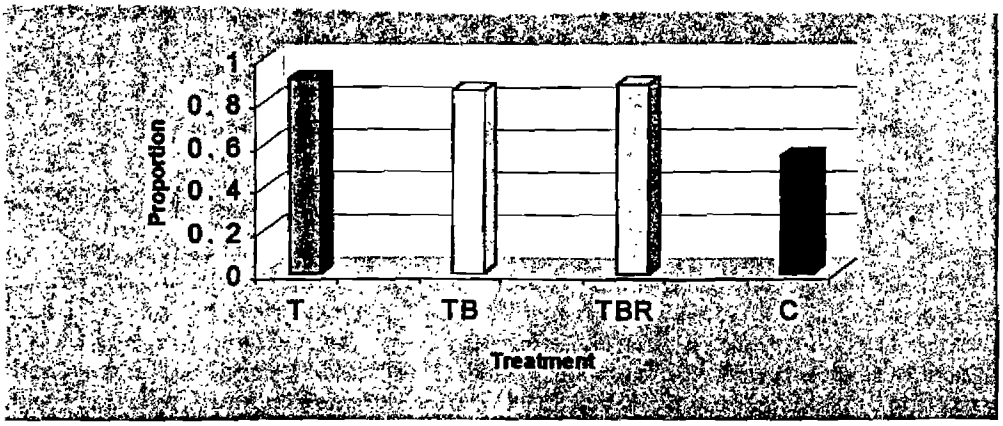

Figure 10. Proportional yields - Marketable to total, Ginger rhizome rot trial, Mt. Moriah, St. Ann (1/98)

Post-harvest Rot

Readings for this parameter were, unavoidably, not taken.

DISCUSSION

Late detection date of the area-wide GRR outbreak (January, 1997), high disease severity and distribution and the fixed planting season (Feb - Jul) demanded a rapid, even if interim, response. As such, the study concentrated on a restricted number of observations, guided by limited background information (Almost all references were obtained after plot establishment).

Treatments were restricted to chemicals, and were based on their activity spectra. Combinations were used to foster success against the different pathogen taxonomic groups involved. Similarly, the less detailed approach allowed only an indication of chemical efficacy and possible relative roles of the pathogens involved. Findings are thus preliminary.

Findings generated agree generally, with similar work on chemical management of fungal GRR in India where most reports on the disease referred to in this study, originated (Dake 1995, Dohroo 1994, Joshi et al 1982, Sahrma et al 1979, Haware et al 1976).

Emergence

The absence of differences in sprout emergence contrasts with most work encountered (Manomohan et al ?, Mathur et al 1984), although one trial (Sharma et al 1979) did show similarity between some chemical treatments and the control. Similar low infestation levels of setts throughout, could account for this. Determination of pre-emergence rot would have allowed clearer indications of differences in eradicant versus protectant chemical activity.

Foliage symptoms

Lower levels of foliage symptoms for chemical treatments compared to the control at 106 DAP, indicate chemical protectant activity. Between-chemical treatment differences are however, inconsistent with activity spectra of the chemicals used. Toppling of symptomatic plants 152 DAP, reduced numbers present then in T and C below levels at first reading.

Ground cover

The more dense ground cover among treated plots at 106 DAP could be due to superior drought tolerance conveyed by greater chemical activity. Increased rainfall in October (**Table 4, Fig. 11**) could have promoted inereased foliage growth throughout the plot at 152 DAP, erasing earlier observed differences. Treated plots would still have an advantage as this earlier growth would foster enhanced assimilation. A close positive correlation observed with marketable yield (**Fig 8**) supports this.

Yield

Superiority of chemical treatments is clearly established by differences in marketable yield and proportions of marketable to total yields. The noted significantly higher marketable yields produced by chemical treatments, suggest potential for a significant improvement in the industry. Absence of differences in total, rotted and unmarketable yields could be due to high variability in the data.

The farmer reported variable unquantified levels of post-harvest rotting among harvested rhizomes. This parameter needs to be properly assessed before a complete chemical GRR management programme can be established.

Table 6. Rainfall, Mt. Moriah, St. Ann - 1997.

Month	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Level (mm)	262	94	112	115	236	70	64	953

Source : Baron Hall Farms weather station

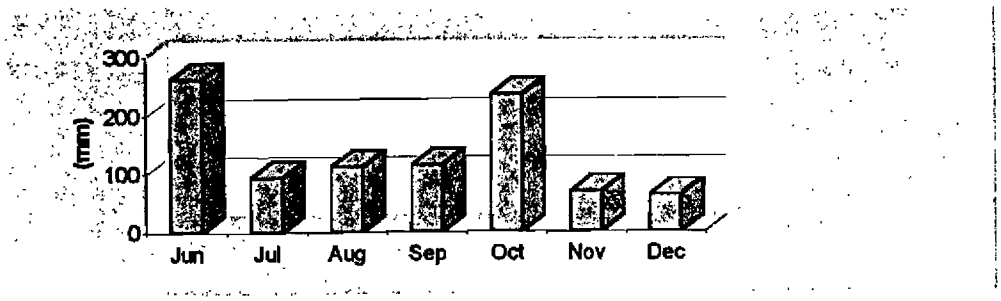

Figure 11. Ginger rhizome rot trial, Mt. Mariah, St. Ann (1977)

Early post-harvest treatment of setts is also indieated. Implications for shelf-life of the green product, pesticide residues in food material, quality of the dried product and supply of planting material are signifieant.

The work is to be repeated in the 1998/99 crop, with a longer dipping period, eounts of toppled plants, determination of post-harvest rot and the inclusion of an organic soil amendment.

This work also indicates the need for further studies as follows:

- Confirm identification of pathogens to the species/sub-species levels.
- Establish disease(s) aetiology and epidemiology including the role (if any) of plant pathogenie nematodes and plant nutrition in development of the disease.
- Validate complementary disease management tactics (e.g. elean planting material/tissue culture, soil amendments, soil solarization, bio-control) and integrated management system(s).
- Pursue possibilities for genetic engineering in disease management and overall commodity development.

Significant yield increases in ginger production may be possible from the use of treated setts. This would support the industry through an increased availability of reasonably healthy planting material. In combination with other disease and crop management tactics, increased volumes could thus be produced at more competitive prices. This should augur well for farmers and the future of Jamaican ginger in the new global economy.

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