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Agronomic performance of three cocoyam (*Xanthosoma violaceum* Schott) genotypes grown in Nicaragua

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Summary

Cocoyam (*Xanthosoma* spp.), the third most important starch food crop in Nicaragua, can be cultivated countrywide. However, very little information about the field performance and genetic background of the different genotypes is available. In this study, the agronomic performance of three purple genotypes established in four locations with different climatic conditions, were evaluated during 2 years. Phenotypic characteristics, yield, and virus incidence were assessed and the time at which the different genotypes reached their physiological maturity was estimated. The trials were based on randomized complete block design with three or four blocks. Genotype × location interaction was found both for phenotypic and yield traits. A differential response of the genotypes to the varying climatic conditions at the locations is suggested to be one of the causes to the interaction. The unpredictable and variable climate in the area where cocoyam traditionally has been grown is one possible explanation to the frequent genotype × year interaction at that location. Other locations with more stable climate only showed an interaction between genotype and year in a few traits. The genotypic differences regarding the time when the area of the largest leaf reached its maximum and the variation in presence of sprouts and roots on the cormels at harvest, indicate differences in optimal harvest time between genotypes. The percentage of plants infected with dasheen mosaic virus (DMV) differed across locations but not between genotypes.

Introduction

Cocoyam (*Xanthosoma* spp.) is a staple root crop that belongs to the Araceae family. It is native to tropical Central and South America and the Caribbean (Montaldo, 1991), and different species within the genus *Xanthosoma* have been cultivated and consumed since the pre-Columbian epoch (López et al., 1995). Cocoyam is an important crop in tropical and subtropical areas because it provides carbohydrates, proteins, fat and vitamins (Wilson, 1984; Tambong et al., 1997; Torres et al., 1994), and a cash income for the farmers (Tambong et al., 1997; Lebot & Aradhya, 1991; Onokpise et al., 1999). In Nicaragua it is the third most important starch crop after potato (*Solanum tuberosum*) and cassava (*Manihot esculenta*).

The major cocoyam producing areas in Nicaragua are located in the humid zones and the production relies on small farmers having 0.5–2.0 ha in production. The production area in Nicaragua has decreased drastically during the last few years, from 30,000 ha in year 2001 to 13,000 ha in year 2002, a decrease that is mainly due to diseases, and unstable prices (MAG-FOR, 2003). The demand for fresh cocoyam has, however, gradually been increasing in Europe and in the United States, and recently, farmers in non-traditional cocoyam-producing areas (northwestern dry zones) have started to establish small commercial areas to expand the production for export.

Although it is an important staple food crop in many tropical countries, cocoyam has received low research priority (Goenaga & Hepperly, 1990). In 1975 The

National Academy of Sciences classified cocoyam as a neglected food crop with economic potential, and it is still regarded as an under-exploited, and insufficiently studied crop (Giacometti & León, 1994; Nguyen & Nguyen, 1987; Watanabe, 2002). According to Goenaga and Chardón (1995), yield potential is seldom realized mainly because of lack of knowledge concerning diseases, proper management practices, and physiological determinants that may limit the growth and development.

Cocoyam produces a subterranean stem called corm, from which smaller offshoots, termed cormels arise. In Nicaragua the corms are used for propagation and animal feeding and the cormels for human consumption and as a cash crop. The crop is vegetatively propagated through pieces of the main corm or whole, small cormels. This type of reproduction guarantees the genetic stability of the material; however, the problem is the spread of bacterial, fungal and viral diseases. Dasheen mosaic virus (DMV) is associated with all edible aroids and the use of vegetative means of propagation has contributed significantly to the worldwide distribution of the virus (Yam et al., 1990; Asokan et al., 1984; Valverde et al., 1997). Other viruses are known to infect members of the genus, but DMV is the most widespread and prevalent (Matthews et al., 1996). Ramírez (1985) reported that DMV infections occurs in at least 80% of all commercial plantations in Costa Rica, however, no reports on its incidence in Nicaraguan cocoyam plantations have so far been published. To date, no work has been published to characterize the existing cocoyam genotypes in Nicaragua.

The objective of this study was to evaluate the agronomic performance of three cocoyam genotypes grown in Nicaragua, under different environmental conditions. Phenotypic characters, yield and virus incidence were assessed, and harvest time was estimated.

Material and methods

Plant material and experimental conditions

The field experiments were established in four different climatic locations (Masaya, Nueva Guinea, Nueva Segovia and Managua) during the rain season in 1999 and 2000, respectively. Nueva Segovia was evaluated only during the first year. Except for Nueva Guinea, where the rain period starts in April, May marks the commencement of the rain season. Descriptions of the environmental conditions prevailing at the test locations and description of the field trials are given in Table 1.

Three genotypes were used in this study, Apalí (AP), Nueva Guinea (NG) and Masaya (MY). To avoid confusion, the genotypes will, from here after, be referred to by abbreviations, while the locations will be referred to by their full names. NG was introduced into Nicaragua from Costa Rica in the mid-80's and was named by farmers and consumers according to the name of the area where it was introduced. The origin of MY is unknown, but it has been cultivated in the Masaya area for more than 100 years**.** AP was introduced into the country from Panama at the beginning of the 90's, and farmers usually refer to this genotype simply as "quequisque", which is the Nicaraguan name for cocoyam. The flesh of the corms and cormels is pink in NG, reddish in AP, and red-purple in MY.

To obtain planting material, corms were split into pieces of 100–150 g containing at least three lateral buds. Before planting, the material was dipped in a water fungicide-bactericide solution (5 ml l^{-1} water of 2-thiocyano-methylthio-benzothiazole) for 5 min.

The experimental set up consisted of a randomized complete block design with three or four blocks (Table 1). Plots were 5 m wide (6 rows) and 13.2 m long (0.6 m between plants) and 3 m between blocks,

Table 1. Environmental conditions and field trial descriptions of the four evaluated locations

	Weather conditions					Field trials description			
Location	Latitude	Average annual rainfall (mm)	Daily mean temperature (°C)	Relative humidity (%)	Elevation (m.a.s.l)	Years	Blocks	Genotypes	Area (m^2)
Masaya	11°58′	1200–1400	27	78	280–400	1999/2000	4	NG, MY and AP	927
Managua	12°08′	1000–1200	28	71	50–60	1999/2000	3	NG and MY	456
Nueva Guinea	13°40′	2000–3000	22	91	150–200	1999/2000	4	NG and MY	618
Nueva Segovia	11°84′	1000–2000	23	85	700–750	1999	3	NG, MY and AP	684

resulting in a plant density of approximately 17,000 plants ha^{-1}.

The soil was plowed and furrowed with animal traction, and four complete fertilizations (170 kg ha^{-1} of 12-30-10 NPK) were made at planting, and 40, 80 and 120 days after planting (DAP). Weeds were manually slashed with machetes and hoes. To cover the scattered fertilizer and to control the weed, soil were earthed up around the plants. The irrigation of the fields was depending on the rainfall in each of the evaluated areas.

Phenotypic characterization

Phenotypic characters were measured once a month on 60–80 plants/genotype, depending on the number of blocks established in each location (Table 1). Data were collected from 20 plants located in the two central rows of each plot. The parameters evaluated were plant height (measured as the distance from ground level to the attachment point between the leaf petiole and the lamina of the tallest leaf), leaf number, number of secondary shoots, pseudo-stem diameter and leaf area of the penultimate leaf. The leaf area was measured according to Morales (1987).

Yield

The cormels were harvested 9 months after planting (MAP). The number of cormels, mean cormel weight, maximum diameter of the cormel, length of the cormels and yield per plant was measured. From these figures the yield in tones per hectare was estimated.

Physiological maturity

To calculate the time at which the different genotypes reached their physiological maturity, the time when the largest leaf of the plants showed the maximum leaf area was recorded. Observations were recorded once a month from 60–80 plants/genotype/location depending of number of blocks in the location (Table 1).

Furthermore, the percentage of cormels with roots and sprouts, respectively, where assessed at harvest time from 20 plants located in the two central rows of each plot**.** The data on rooting/sprouting were collected only during year 2000.

Dasheen mosaic virus

The percentage of plants with visible symptoms of DMV was recorded at around 120 DAP. The data were collected from 414–552 plants/genotype/location depending of the number of blocks in the location.

To verify the presence of DMV, 40 plants/genotype/location with visible symptoms of virus infection were subjected to an ELISA test (AGDIA pathoscreen kit). Moreover, to estimate the percentage of plants infected with DMV in the plantations, 15 randomly selected plants/block/genotype in each location were screened, 90 DAP, using the ELISA test. The ELISA tests were performed only during 1999.

Data analysis

The phenotypic data and the yield components were submitted to analysis of variance (Procedure GLM in SAS, SAS Institute Inc., 1996). The analyses were performed on plot means. Tukey tests were used to separate means in effects where significant statistical differences were found. The following linear models were used:

1. $Y_{jkm} = \mu + B_j + G_k + e_{jkm}$
2. $Y_{ijkm} = \mu + \text{Loc}_i + B_{j(i)} + G_k + \text{Loc}^* G_{ik} + e_{ijkm}$
3. $Y_{jklm} = \mu + \text{Ye}_l + B_j + G_k + \text{Ye}^* G_{lk} + e_{jklm}$
4. $Y_{ijlm} = \mu + \text{Loc}_i + B_{j(i)} + \text{Ye}_l + \text{Loc}^* \text{Ye}_{il} + e_{ijlm}$

where $Y_{jkm}, Y_{ijkm}, Y_{jklm}, Y_{ijlm}$, are the phenotypic means, μ is the overall mean, Loc_i is the fixed effect of the ith location, B_j, $B_{j(i)}$ are the random effect of the jth block or the jth block within location, G_k is the fixed effect of the kth genotype, Ye_l is the fixed effect of the lth year, $\text{Loc}^* G_{ik}$ is the fixed effect of the interaction between the ith location and kth genotype, $\text{Ye}^* G_{lk}$ is the fixed effect of the interaction between the lth year and kth genotype, $\text{Loc}^* \text{Ye}_{il}$ is the fixed effect of the interaction between the ith location and lth year and $e_{jkm}, e_{ijkm}, e_{jklm}, e_{ijlm}$ are random errors.

Model 1 was used for analysis of genotypic differences at each location in each year; and model 2 for analysis of the effect of location for each year. Model 3 was used to analyze the effect of year at locations Masaya, Managua and Nueva Guinea and model 4 was utilized for analysis of the effect of location and year for the genotypes MY and NG. Models 2 and 3 were analyzed with an unbalanced design, since AP was not tested at all locations, and Nueva Segovia was tested only during year 1999. If the interactions between the fixed effects in models 2, 3 and 4 were significant, the testing of each effect was not possible since the F-test assumes non-significant interactions.

Results

Phenotypic characterization and yield

The effect of genotype at each location and year

The mean values and statistical differences between genotypes in each field trial are presented in Table 2. Significant differences ($P \leq 0.05$) between the genotypes were mainly found in Masaya, both years, and in Nueva Segovia. In Nueva Guinea 1999 mean cormel weight was the only trait that differed significantly between the genotypes, while number of leaves, number of cormels and yield per plant differed between the two genotypes in 2000. In Managua no significant differences were found between the two genotypes for any of the traits in any of the years. The genotypes did not show statistical differences for the number of leaves or cormel diameter, at any of the locations during any of the years, except for number of leaves in Nueva Guinea during the second year.

The effect of genotype and location during each year

The genotype × location (G × L) interaction (model 2) was significant in seven of the variables in 1999 and in five in 2000 (Table 3). MY for example, showed the highest values for plant height in Masaya year 2000, while at the rest of the locations no significant effect between genotypes could be found, thus causing the G × L interaction. All yield components in year 1999 and three of them in year 2000 were influenced by the G × L interaction. For traits not influenced by the G × L interaction, the effect of location and genotype was significant for some of the traits. For example, the highest number of leaves was produced in Managua, and MY showed the widest pseudostem diameter during both years (Tables 2 and 3).

The interaction effect of genotype and year at each location

Interactions between genotype and year (model 3) were mainly found in Masaya. Five of the ten traits; height of plant ($P < 0.001$), leaf area ($P < 0.001$), number of secondary shoots ($P < 0.001$), mean cormel weight ($P < 0.01$) and yield per plant ($P < 0.05$) showed significant interaction effects in Masaya. Cormel length was the only trait showing an interaction effect in Managua ($P < 0.05$). In Nueva Guinea cormel length ($P < 0.01$) and

Table 2. Mean values and statistical significance (model 1) for phenotypic variables at 180 DAP and yield components at harvest time recorded from plants of MY, NG and AP genotypes established in four locations during 2 years

			Phenotypic variables					Yield components					
Year	Locations	Genotypes	Plant height (cm)	Diameter of pseudo-stem (cm)	Number of leaves	Leaf area (cm^2)	Number of secondary shoots	Number of cormels	Cormel length (cm)	Cormel diameter (cm)	Mean cormel weight (g)	Yield per plant (g)	Estimated yield ($t\,ha^{-1}$)
1999	Masaya	MY	91.4 a	6.6 a	3.9 a	1067 a	0.40 b	3.2 b	8.2 ab	4.1 a	77.8 a	234 a	4.0
		NG	76.6 b	5.1 b	4.9 a	674 b	1.05 a	4.5 a	8.5 a	3.8 a	61.8 b	264 a	4.5
		AP	72.2 b	5.4 b	3.8 a	769 b	0.28 c	3.3 b	7.3 b	3.9 a	60.9 b	174 a	3.0
	Managua	MY	75.5 a	7.0 a	4.4 a	1020 a	1.12 a	2.1 a	7.9 a	3.8 a	79.5 a	161 a	2.7
		NG	87.4 a	7.2 a	4.9 a	1059 a	0.75 a	2.8 a	8.4 a	4.0 a	76.9 a	208 a	3.6
	Nva Guinea	MY	89.5 a	6.4 a	4.3 a	1456 a	0.52 a	3.2 a	17.8 a	8.7 a	187.9 a	612 a	10.4
		NG	83.6 a	5.4 a	4.2 a	1166 a	0.33 a	3.9 a	15.8 a	7.7 a	144.5 b	570 a	9.7
	Nva Segovia	MY	93.2 a	6.7 a	3.8 a	1363 a	0.38 a	3.7 b	7.8 a	3.8 a	67.0 a	249 b	4.2
		NG	97.3 a	5.4 b	3.4 a	1090 b	0.47 a	4.9 b	7.6 a	3.7 a	55.1 b	274 ab	4.7
		AP	73.2 b	5.5 b	3.6 a	986 b	0.44 a	8.3 a	8.0 a	3.9 a	48.3 c	365 a	6.2
2000	Masaya	MY	111.4 a	8.6 a	5.1 a	2879 a	0.25 a	3.8 a	9.9 a	4.2 a	111.0 a	417 a	7.1
		NG	87.7 b	6.6 b	4.6 a	1429 b	0.25 a	4.5 a	9.8 a	4.2 a	54.0 b	331 b	5.6
		AP	68.0 c	5.2 c	4.5 a	2952 a	0.10 b	3.7 a	8.1 a	4.2 a	87.0 a	249 c	4.2
	Managua	MY	70.5 a	6.5 a	5.1 a	1213 a	1.10 a	2.5 a	6.5 a	5.2 a	55.0 a	134 a	2.3
		NG	65.8 a	5.6 a	4.9 a	1256 a	1.25 a	2.4 a	9.9 a	4.8 a	80.0 a	187 a	3.2
	Nva Guinea	MY	68.9 a	6.4 a	3.9 a	1479 a	0.13 a	2.9 b	11.0 a	5.2 a	130.0 a	370 b	6.3
		NG	62.9 a	5.2 a	3.6 b	1085 a	0.17 a	3.8 a	12.3 a	4.8 a	121.0 a	464 a	7.9

Means in columns followed by the same letter do not differ significantly according to Tukey mean comparison test ($P < 0.05$).

Table 3. Analysis of variance for phenotypic variables and yield components over all locations and during 2 years using model 2

Source of variation	Phenotypic variables					Yield components				
	Plant height (cm)	Pseudo-stem diameter (cm)	Number of leaves	Leaf area (cm^2)	Number of secondary shoots	Number of cormels	Cormel length (cm)	Cormels diameter (cm)	Mean cormel weight (g)	Yield per plant (g)
Year 1999/2000										
Location	–/–	ns/ns	* /* * *	* /–	–/* * *	–/* * *	–/–	–/**	–/–	–/–
Block (Loc)	** /**	* /* * *	ns/ns	** /*	ns/**	ns/ns	ns/ns	ns/ns	* /*	ns/ns
Genotype	–/–	** /* * *	ns/ns	* * * /–	–/**	–/ns	–/–	–/ns	–/–	–/–
Genotype × location	** /**	ns/ns	ns/ns	ns/* * *	* /ns	* * * /ns	* /*	* /ns	* /* * *	* /* * *

*, **, * * * indicate significant *F* values at the $P < 0.05$, 0.01 and 0.001 levels respectively; ns: no significant effect; –: if G × L interactions are significant then a correct *F*-test of location and genotype is not possible since the test is assuming non significant interactions.

mean cormel weight ($P < 0.05$) showed significant interactions.

The interaction effect of location and year for each genotype

Specific environmental conditions during the years have caused a shift in ranking across locations from 1 year to the other and thus a location × year (L × Y) interaction in the performance of MY and NG (model 4). The L × Y interaction was significant ($P < 0.05$) or highly significant ($P < 0.001$) for all traits except for pseudo-stem diameter, number of leaves and number of cormels for MY. In NG genotype half of the traits showed significant interaction effects where height of plant ($P < 0.05$), number of secondary shoots ($P < 0.001$), cormel length ($P < 0.01$), cormels diameter ($P < 0.001$) and yield per plant ($P < 0.05$) were significant.

Physiological maturity

The genotypes differed in the time at which the largest leaf reached the maximum area. On average, MY reached the maximum leaf area three weeks later than the other genotypes.

Figure 1 shows the development of the maximum leaf area of the largest leaf in Masaya (1999).

At harvest time, the number of the cormels with sprouts and roots varied between genotypes. In Nueva Guinea, 60% of the cormels of NG had roots and 34% had sprouts. Similar figures were found for NG in Masaya, where 64% and 37% produced roots and sprouts, respectively. The corresponding figures for MY were 17% and 13% in Nueva Guinea, and 20% and 16% in Masaya. In Managua, cormels with roots and sprouts were found only occasionally, in the genotypes mentioned above. AP was investigated only in Masaya, where 42% of the cormels had produced roots and 28% sprouts.

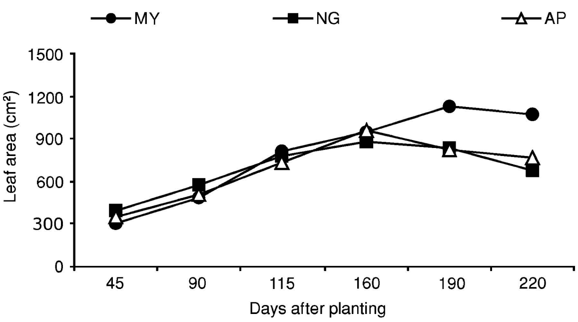

Figure 1. Development of the area of the largest leaf (Masaya, 1999).

Dasheen mosaic virus

The ELISA test indicated that the plants showing the feather-like symptoms associated with DMV actually contained the virus. In general, the percentage of plants with visible symptoms of DMV did not vary between genotypes within a certain location (Nueva Guinea, 47–48%, Managua, 26–27%, Masaya, 20–27%), except in Nueva Segovia where twice as many plants of NG showed symptoms of the virus compared to the other genotypes (16–38%).

Differences between locations were found, and the highest percentage of plants with visible symptoms, regardless of genotype, was found in Nueva Guinea (48%). The ELISA test showed however another picture. In Masaya and in Managua nearly 100% of the plants were infected with DMV, while in Nueva

Segovia and Nueva Guinea the percentage of infected plants was somewhat lower (68–85%). Overall, the actual number of plants with virus infection was much higher than the screening for visible symptoms indicated.

Discussion

Phenotypic characterization and yield

Genotype × location interaction (G × L) was found for all yield components the first year and was consistent for three of them also the second year. Possible causes for the interaction could be specific climatic factors at the different locations that make a ranking shift between genotypes from one location to the other. The rain forest conditions in Nueva Guinea as well as the high altitude in Nueva Segovia might be the main factors influencing the response of the genotypes. A temporal drought reported in Masaya in 1999 might also be a possible explanation for the different responses of the genotypes regarding yield components. According to Onwueme and Charles (1994) the yield of cocoyam varies from place to place, depending on the cultivation methods and the environmental conditions, and G × L interactions for growth traits have previously been reported for cocoyam (Torres et al., 1994, 2000; Valverde et al., 1997; Igbokwe, 1983). An explanation to the inconsistency of significant G × L interaction for number of cormels/plant between year 1999 and 2000 is that AP, showing a significant higher number of cormels at Nueva Segovia in year 1999, was not evaluated in year 2000.

In the case of the leaf area a non-significant G × L interaction was found during year 1999; however, MY showed the largest leaf area and in general the largest leaf area was produced in Nueva Guinea. In contrast to year 1999 a highly significant G × L interaction was found for leaf area during year 2000. A significant difference in leaf area between the genotypes in Masaya but not in the other locations could explain this finding.

For number of secondary shoots/plant a G × L interaction was found in1999 but not in year 2000. According to Wilson (1984) the number of shoots depends initially on the genotype but is modified by the environment and cultural practices. In the present study the production of secondary shoots was stimulated by the water stress conditions in Managua during both years and by a temporal drought early in the growing season in Masaya in 1999. Another factor influencing the formation of secondary shoots is the amount of sunlight that reaches the soil. Plants established in Managua 1999 and 2000 and in Masaya 1999 were generally less vigorous during the early stages of growth than plants in the other locations (data not shown). This resulted in less shading of the soil surface, which might have contributed, to the increased amount of plants with secondary shoots in these areas. A difference in response of the genotypes to these factors might explain the G × L interaction found for secondary shooting during 1999.

Looking at each location separately, Masaya was the location where most frequent genotype × year interactions (G × Y) were found. The drought period in Masaya during 1999 is probably one of the reasons for the ranking shift of the genotypes from year 1999 to year 2000. One of the features of cocoyam is its high water requirement during the initial stages of growth, and a rainfall between 1400–2000 mm/year is required to obtain optimal growth and development (Onwueme and Charles, 1994; Goenaga, 1994). Any water stress during the growing period can retard the general growth and reduce the yield (Caesar, 1980; Onwueme, 1978; Torres et al., 1994, 2000), however the water requirement is genotype dependent (Torres et al., 2000). The stable climatic conditions in Managua and Nueva Guinea during the study could explain the few significant G × Y interactions found in these locations. Both MY and NG showed significant year × location interaction (Y × L) in many of the traits (seven of ten for MY, five of ten for NG) caused by altered performance in the different locations from year 1999 to 2000. Both genotypes produced the highest yields, recorded in this study, in Nueva Guinea in 1999. In year 2000, there was a significant reduction in yield at that location for both genotypes. These differences in yield between 1999 and 2000 might be due to root rot disease, a fungal-bacterial complex disease reported for the first time in the area by INTA (2000), but not registered in this study.

Physiological maturity

At harvest time, the number of the cormels with sprouts and roots varied between genotypes. The starch degradation that occurs in connection with rooting and sprouting decreases the yield and deteriorates the quality of production. Genetic differences in sprouting and rooting of cormels as a result of delayed harvest have been reported by Goenaga & Chardón (1993), Chandler et al. (1982), Onwueme & Charles (1994) and it is therefore of utmost importance to define the time at which each genotype should be harvested to obtain optimal yield.

In the present study, the plants were harvested 9 months after planting, as the Nicaraguan farmers traditionally do. This seems to be a fairly suitable time for the old traditional genotype MY, but unsuitable for the more recently introduced genotypes.

Besides the genetic predisposition for sprouting/rooting, the water supply in the end of the growing season has been reported to play an important role (Onwueme & Charles, 1994). Any water supplied after the time when the cormels have reached maturity results in growth of the root and shoot meristems of the cormels. The percentage of cormels with roots and sprouts did not vary between the Masaya and Nueva Guinea areas, even though the annual rainfall differs between the two locations, indicating that the genetic predisposition for resuming growth was the main determining factor. The dry conditions in the Managua area prevented the cormels to resume growth, and very few cormels with roots/sprouts were found. However, since cocoyam is a crop that requires ample moisture throughout the growing season, the drought in this area affected the yield negatively. The fact that NG and AP reached the maximum leaf area and that plant height peaked approximately three weeks before MY also supports the idea that the different genotypes need to be harvested at different times after planting.

Dasheen mosaic virus

In this study, the actual percentage of DMV-infected plants was much higher than the visible screening for symptoms indicated. The symptoms of DMV in cocoyam is quite characteristic with a mosaic, mottle and chlorotic feathering of the leaves. However, since the symptoms are intermittently expressed (Zettler et al., 1989), plants without symptoms could still be infected by the virus.

Aphids are almost exclusively the way by which DMV is transmitted (Brunt et al., 1996), and high temperature and low rainfall are ideal conditions for their reproduction and movement (CIP, 2002). The higher percentage of infections found in Managua and Masaya compared with Nueva Guinea and Nueva Segovia might therefore be due to differences in the climatic conditions between the test sites, which in turn affected the aphid population density and the DMV transmission. The virus is transmitted in a non-persistent manner, which could explain the existence of virus-free plants under field conditions.

Conclusions

The production of cocoyam in the rain forest area of Nueva Guinea, where the climate is stable and humid, was generally higher than in the other areas. The unpredictable and variable climate in Masaya, the traditional cocoyam producing area, is one of the main factors influencing the yield over years. The water stress conditions prevailing in Managua (1999 and 2000) and in Masaya in year 1999, favored the production of secondary shoots from the corms.

The time when the area of the largest leaf reached its maximum value, and the percentage of cormels with roots and sprouts at harvest differed between genotypes, suggesting that NG and AP should be harvested at least three weeks before MY.

The percentage of plants infected with DMV was much higher than the visual screening for symptoms indicated. No genotypic differences regarding percentage of infected plants were found; however, due to climatic differences, there was a variation between locations.

The recent introduction of planting material to Nicaragua from other countries has been conducted without previous knowledge concerning diseases and the performance of the genotypes, also depending to a large extent on the cultural practices and environmental conditions. Information generated in the current study can be used to optimize the agronomic management of the crop in commercial areas, as well as giving basic knowledge for potential studies on nutrient uptake, water requirement, disease resistance, management practices and propagation methods.

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