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STUDIES ON THE CRITICAL PERIODS OF WEED COMPETITION IN YAMS (DIOSCOREA ROTUNDATA POIR AND DIOSCOREA ALATA)

Etudes sur les périodes critiques de compétition des mauvaises herbes avec les ignames (D. rotundata Poir et D. alata)

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SUMMARY

Field experiments were conducted at Corozal and Isabela, Puerto Rico and Guapiles, Costa Rica to determine the critical periods of weed competition in yams (*Dioscorea rotundata* Poir and *Dioscorea alata*). The experiments were carried out under high input agriculture where the crop was fertilized, staked, and prevention practices for disease, insect and nematode control taken.

At Corozal and Guapiles, the predominant weeds were grasses. At Isabela, grasses were among the most important weeds, but morninglory (*Ipomoea tiliacea*) was the predominant weed. The critical period in which weeds need to be controlled to avoid yield losses was found between 4 and 10 weeks for Costa Rica and between 8 and 10 weeks for Puerto Rico.

RESUME

Les expérimentations culturales ont été conduites à Corozal et Isabela à Puerto Rico et Guapiles au Costa Rica, pour déterminer les périodes critiques de compétitions des mauvaises herbes avec les ignames D. rotundata *Poir et* D. alata. *Les expérimentations ont été faites en culture intensive, fertilisée, tuteurée, traitée préventivement contre les maladies, insectes et nématodes.*

A Corozal et Guapiles les mauvaises herbes prédominantes étaient des graminées. A Isabela, elles étaient aussi parmi les plus importantes, mais Ipomoea Tiliacea *était prédominante. La période critique pendant laquelle le contrôle des mauvaises herbes éviterait les pertes de rendement était entre la 4e et la 10e semaine au Costa Rica et entre la 8e et la 10e semaine à Puerto Rico.*

INTRODUCTION

Yams are staples foods in parts of Western africa and the Caribbean. World production was 22 million metric tons worth US$3.5 billion in 1981 (Horton et al, 1983). During 1983, 2.5 million hectares were planted world-wide and production amounted to 23.3 million metric tons (FAO Production Yearbook, 1983). In Puerto Rico, yams are the most important root and tuber crops. Production was worth US$ 8 million at the farm level during 1980-81. During 1983, 2000 hectares were planted, yielding 13 000 metric tons (FAO Production Yearbook, 1983). Yams are not widely consumed in Costa Rica. Although only 100 hectares are under production, a profitable export market exists for the crop.

In Puerto Rico and Costa Rica, the crop is grown by small scale farmers with limited resources under hot and humid conditions. Annual rainfall varies from 1500 mm in Puerto Rico to over 3000 mm in Costa Rica. At both countries, the range in temperatures in the yam growing regions is from a minimum average of 19°C to a maximum average of 30°C. Under these conditions, weeds thrive. The long growing season of the crop (7 to 10 months) increments the weed competition problem.

The size of yam plantings generally ranges from 0.8 to 1.2 ha (Gonzalez- Villafane et al, 1980) in Puerto Rico. In Costa Rica, most of the plantings are of less than 1.0 ha. Mechanization has not been possible because of the relatively high costs of machinery and the moist conditions of the soil. The sloping nature of the land under yam production is an added problem in Puerto Rico.

Few herbicides are legally allowed for use in yams in Puerto Rico. In Costa Rica, herbicides generally are very expensive. Hand weeding is in many cases the best alternative for weed control. However, hand labor is scarse and expensive in the yam growing regions of both countries.

The topography of the land and the high rainfall which prevails in the central mountain region of Puerto Rico where yams are grown favors soil erosion where no ground cover is available to prevent it. Weeds, although detrimental for crop production, serve as ground cover and prevent erosion.

The fertile soils of Costa Rica, together with the other favorable climatic conditions favors a weed pressure which requires very frequent hand weedings to keep the crop weed free. The costs of weedings are high, and the risk of damage to the crop's roots is serious. Therefore, it is desirable to determine the stage (s) of the crop growth cycle when weeds have an adverse effect on its production. If weeds are controlled only at these stages, the costs of production would be lessened, the risks of erosion reduced and mechanical damage to the roots minimized. The objective of this study is to determine the stages in the growth of

yam (*Dioscorea rotundata* Poir and *D. alata*) in which weed competition does not cause a detrimental effect on yield.

MATERIALS AND METHODS

A series of three experiments were planted at the Corozal and Isabela Research and Development Centers of the Agricultural Experiment Station of the University of Puerto Rico, and at a private farm in Guapiles, Costa Rica. The dates of planting and harvest, climatic data, altitude, species and cultivar of yam, statistical design, number of treatments and replications, plot size, and total and experimental plants per plot are shown in Table 1. The soil type, texture and chemical analyses of the three sites are shown in Table 2. The agronomic management practices carried out at the three experiments are shown in Table 3.

The principal species, *Dioscorea rotundata* in Puerto Rico and *D. alata* in Costa Rica, was used for the experiment in each country. Seed pieces were prepared by cutting off and discarding both the proximal and distal ends of the tuber, and sectioning the remainder into pieces ranging from 100 to 170g. Immediately after cutting, they were dipped in a solution containing thiabendazole with or without oxamyl. After treatment, the seed pieces were spread in a shaded area and allowed to suberize for a few days. At Guapiles, they were covered with moist wood shavings for two weeks.

Seed pieces were planted on the top of the beds and completely covered with soil. A month to six weeks after planting, yam vines were either staked individually or tied to a wire. At Corozal, aldicarb was applied to the soil at 0.22 g a.i. per m of bed length. Applications of oxamyl and methomyl were made to the foliage in the later part of the season for further control of nematodes and insects. At Guapiles, benomyl at 0.2 to 2.0 and captafol at 2 kg i.a./ha were applied to the foliage at regular intervals as a prevention of anthracnose (*Colletotrichum gloeosporioides*).

A set of the experimental treatments consisted of hand weeding the crop for a specified period from planting and allowing free weed growth thereafter. While a second set of treatments consisted in allowing free weed growth for a specified period after planting and hand weeding the yams thereafter until harvest. Two control treatments were included: 1) Hand weeding from planting to harvest, and 2) no weed control. Treatments for the three experiments are shown in Table 4.

The set of treatments hand weeded for a specified period after which free weed growth was allowed were hand weeded at the following weeks from planting:

TABLE 1. Dates of planting and harvest, climate, altitude, species and cultivars of yam, statistical designs, number of treatments and replications, plot size, total and experimental number of plants per plot of experiments at Corozal and Isabela, Puerto Rico, and Guapiles, Costa Rica.

	Corozal	Isabela	Guapiles
Date of planting	July 29, 1981	April 8, 1982	February 13, 1984
Date of harvest	May 13, 1982	December, 1982	November 20, 1984
Rainfall[1/] (mm)	1650	1769	3200
Mean maximum temperature (°C)	30	30.4	26 to 30
Mean minimum temperature (°C)	19	19	19 to 21
Altitude (masl)	200	128	80
Species	D. rotundata	D. rotundata	D. alata
Cultivar	Guinea Negro	Guinea Blanco	Antillano
Statistical design	Partially balanced incompleate blocks	Randomized complete blocks	Randomized complete blocks
Number of treatments	10	11	16
Number of replications	5	5	5
Plot size (m^2)	27.6	17.9	39
Total number of plants per plot	60	28	75
Number of experimental plants/plot	30	10	33

1/ For Corozal mean annual rainfall, for Isabela rainfall during growing season + irrigation, for Guapiles rainfall during growing season.

TABLE 2. type, texture and chemical analyses of the soils at the experimental sites in Corozal ans Isabela, Puerto Rico, and at Guapiles, Costa Rica.

	Corozal	Isabela	Guapiles
soil type	Aquic Tropudults	Tropeptic Haplorthox	Typic Distrandept
Texture sand (%)	23	35-53	43-67
Silt (%)	29	24-44	22-38
Clay (%)	48	17-27	7-19
pH	5.0 to 5.4	5.9 to 6.5	5.3 to 5.8
Organic matter	2.2 to 3.2	4.3 to 5.2	5.2 to 8.1
p (ppm)[1/]	0 to 2	7.2 to 11.7	4.4 to 4.9
K (ppm)	178 to 393	245 to 270	68 ot 117
Ca	1538 to 1929	-	220 to 620
Mg	103 to 149	70 to 120	60 to 96

1/ Bray I method for Corozal, Bray II for Isabela and Olsen for Guapiles

TABLE 3. Crop management practicies for the experiments at Corozal and Isabela, puerto Rico and Guapiles, Costa Rica.

	Corozal	Isabela	Guapiles
Seed piece weight (g)	112-128	140-170	100-150
Chemical treatment of seed piece:			
Thiabendazole (ml/l)	10	2.6	2
Oxamyl (ml/l)	10	3.2	0
Time of inmersion (min.)	15	10	10-15
Planting distance (m)	1.5 x 0.3	1.2 x 0.6	1.5 x 0.35
Area per plant (m^2)	0.45	0.72	0.53
Fertilization at planting (kg/ha)	-	-	150 kg/ha P_2O_5
Other fertilization (N-P-K-Mg) (kg/ha)	180-78-300-60	110-87-87-0	230-23-230-0
Timing of fertilization (months after planting)	1 and 3	2.25 and 4	3.5
Fertilizer formula	8-8-12 + sulpo MAG	8-8-12	TSP and 20-3-20
Staking height (m)	Tied to wire	Tied to wire	Individual
	1.5	1.2 to 1.4	stake 2.3
Fungicide applied to foliage (kg)	-	-	Benomyl 0.2-2.0 per application

TABLE 4. Treatments of the experiments conducted at Corozal and Isabela, Puerto Rico, and at Guapiles, Costa Rica.

	Corozal	Isabela	Guapiles	
Hand weeding for	-	4	4	Weeks, no weed control thereafter
" " "	-	8	8	" " " " "
" " "	10	-	10	" " " " "
" " "	-	12	12	" " " " "
" " "	-	-	14	" " " " "
" " "	-	16	16	" " " " "
" " "	17	-	-	" " " " "
" " "	-	20	20	" " " " "
" " "	22	-	-	" " " " "
" " "	-	24	-	" " " " "
" " "	28	-	-	" " " " "
" " "	37	-	-	" " " " "
	the whole season			
Weed competition for	-	4	4	Weeks, hand weeding thereafter
" " "	-	8	8	" " " "
" " "	10	-	10	" " " "
" " "	-	12	12	" " " "
" " "	-	-	14	" " " "
" " "	-	16	16	" " " "
" " "	17	-	-	" " " "
" " "	-	20	20	" " " "
" " "	22	-	-	" " " "
" " "	-	24	-	" " " "
" " "	28	-	-	" " " "
" " "	37	-	-	" " " "
	the whole season			

Weeded until week :	Hand weeding carried out a week number :
COROZAL	
10	10
17	10,17
22	10,17, 22
28	10,17, 22, 28
37	10,17, 22, 28, 37
ISABELA	
4	4
8	4, 8
12	4, 8, 12
16	4, 8, 12, 16
20	4, 8, 12, 16, 20
24	4, 8, 12, 16, 20, 24
GUAPILES	
4	4
8	4, 8
10	4, 8, 10
12	4, 8, 10, 12
14	4, 8, 10, 12, 14
16	4, 8, 10, 12, 14, 16
20	4, 8, 10, 12, 14, 16, 20
the whole season	4, 8, 10, 12, 14, 16, 20, 24, 28

The second set of treatments, where weed growth was allowed for a specified period, were hand weeded from then until harvest at the same interval as the other experimental treatments receiving hand weeding. At Corozal, for instance, the treatment where free weed growth was allowed until the 10th week received hand weedings at 10, 17, 22, 28 and 37 weeks after planting. At Guapiles, the same treatment, where free weed growth was allowed until the 10th week received hand weedings at 10, 12, 14, 16, 20, 24 and 29 weeks after planting.

RESULTS

The total yield of tubers for the experiments at Corozal and Guapiles and the yield of commercial tubers at Isabela are shown in Table 5. At Corozal, no differences were found between the treatment hand weeded only at 10 weeks after planting, and those weeded from 10 weeks on, including the one hand weeded until harvest. Where weed competition was allowed for 17 weeks after planting, lower yields were obtained than where allowed for 10 weeks, indicating that hand weeding must begin before the 17th week in order to

TABLE 5. Total yield of tubers in the experiments at Corozal, Puerto Rico and Guapiles, Costa Rica, and commercial yield of tubers at Isabela, Puerto Rico.

	Corosal	Isabela	Guapiles
		t/ha	
Hand weeded for 4 weeks, free weed growth thereafter		6.92c	33.39 bcd
" " " 8 " " " " "		20.82b	34.92 bcd
" " " 10 " " " " "	18.507a		39.93abc
" " " 12 " " " " "		30.60a	41.25abc
" " " 14 " " " " "			41.64ab
" " " 16 " " " " "		26.67a	40.80abc
" " " 17 " " " " "	20.621a		
" " " 18 " " " " "			
" " " 20 " " " " "		29.95a	36.87abcd
" " " 22 " " " " "	23.750a		
" " " 24 " " " " "		25.98a	
" " " 28 " " " " "	22.865a		
" " " 37 " " " " "	20.978a		
the whole season			44.77a
Weed competition for 4 weeks, hand weeding thereafter		25.98a	44.10a
" " " 8 " " " " "		27.01a	33.28cd
" " " 10 " " " " "	21.239a		35.44bcd
" " " 12 " " " " "		17.95b	36.62abcd
" " " 14 " " " " "			34.88bcd
" " " 16 " " " " "		7.39c	36.83abcd
" " " 17 " " " " "	13.205b		
" " " 18 " " " " "			
" " " 20 " " " " "		5.79c	40.44abc
" " " 22 " " " " "	7.155bc		
" " " 24 " " " " "			
" " " 28 " " " " "	5.870c		
" " " 37 " " " " "	6.033c		
the whole season		3.91c	29.15bd

avoid yield losses.

Yields at Corozal were further reduced when weed competition was allowed for 28 or more weeks as compared to 17 weeks. Thus, it is still feasable to hand weed fields which have been weed infested for 17 weeks, for there will be a response in production.

At Isabela, no differences in commercial yield were found between the treatment hand weeded throughout the whole cycle, and those where weeding was begun at 8 weeks after planting. Yields were decreased when weeding was begun at 12 instead of at 8 weeks after planting. Therefore, results show that it is not necessary to control weeds for the first 8 weeks from planting, but weed control operations must begin between 8 and 12 weeks after planting.

Yields were lower where hand weeding operations were carried out only at 4 weeks than where carried out until the 8th week from planting. They were also lower where hand weeding was conducted until the 8th week as compared to hand weeding until the 12th week from planting. No differences in yield were found between hand weeding for 12 weeks or more and the treatment kept hand weeded throughout the growing season.

The results at Isabela show that weeding operations are necessary between the 8th and the 12th week from planting. Weeding operations before the 8th or after the 12th week would be wasteful because they do not have an effect on yield

At Guapiles, decreases in yield due to weed competition were low. Only a 35% difference in yield was found between treatments hand weeded throughout the season and those which were never hand weeded. Yields were higher where weed competition was allowed for 4 weeks than where allowed for 8 weeks from planting. They were also higher where the weeding was begun at 4 weeks and continued until harvest than where no weed control was made. However, no differences were found between the treatments where weed competition was allowed for 8, 10, 12, 14, 16 or 20 weeks after planting. Results indicate that some weeding is necessary and that weeding operations begun at 4 weeks after planting were associated with the highest yields obtained in the experiment.

Treatment hand weeded up to 4 or 8 weeks after planting yielded less than where weeds were controlled from planting to harvest. However, no differences in yield were obtained between treatments hand-weeded to the 10th, 12th, 14th, 16th or 20th week after planting or where hand weedings were carried out throughout the season. The results show that after the 10th week from planting, additional weeding operations do not affect yam yields. The critical period in which weeds have an adverse effect on yam yields is between the 4th and the 10th week from planting.

The weeds present at the three sites are shown in Table 6. At Corozal and Guapiles, the predominant weeds were grasses. At Isabela, grasses were also among the most important weeds, but the predominant weed was a vine, morning-glory *(Ipomoea tiliacea)*.

Crabgrass *(Digitaria sanguinalis)* was the predominant weed species at Guapiles, although there was also an abundance of browntop panicum *(Panicum fasciculatum)* sourgrass *(Pasapalum conjugatum)*, tickle grass *(Panicum trichoides)* goose-grass *(Eleusine indica)* and of the broadleaf weeds *(Melanthera aspera)* and *(Momordica charantia)*. At Corozal, both guinea grass *(panicum maximum)* and crabgrass were the predominant species, although caesarweed *(Urena lobata)*, goosegrass, spurge *(Euphorbia heterophylla)*, Jungle rice *(Echinocloa colonum)* bermuda grass *(Cynodon dactylon)*, spreading dayflower *(Commelina diffusa)* and *Momordica charantia* were also important.

Important weeds at Isabela were spurge, johnsongrass *(Sorghum halepense)*, *Brachiaria purpurescens*, southern sandbur *(Cenchrus echinatus)*, *Axonopus Compressus* and guinea grass. Broadleaves were predominant during the first 24 weeks from planting, while grasses became predominant after the 24th week.

While the main weed species at Guapiles and Corozal were low lying weeds, at Isabela, the predominant weed species during the first six months of growth had a similar growth habit as the yam plant.

The dry weight of weeds in the experiments at Isabela and Guapiles are shown in Table 7.

In general, weed dry weights were higher at Guapiles than at Isabela. However, there was a slow growth of weeds during the first 4 weeks from planting at Guapiles. During this period, weed growth at Isabela was over 7 times faster (1000 kg/ha vs. 131 kg/ha). The slow weed growth was caused by very little rainfall during the first few weeks after planting. This low weed weight at Guapiles was associated with one of the highest yields of yam (44.10 t/ha). The dry weight of weeds at both sites continued to increase as the interval of free weed growth was increased from 4 weeks until harvest. At Guapiles, the dry weight of weeds where competition was allowed until harvest (4450 kg/ha) was higher than where allowed until the 20th week (3039 kg/ha), which was statistically higher than where allowed to the 10th week (1445 kg/ha). Results indicate that weed weights did not reach an equilibrium during the growing season at Isabela or Guapiles.

At both sites weed weights at harvest were reduced to one half by hand weeding up to the 8th week instead of to the 4th. At Guapiles, hand weeding to the 10th week (1432 kg/ha) caused a three fold reduction in weed weight

TABLE 6. Predominant weed species in the timing of weed competition experiments at Corozal and Isabela, Puerto Rico, and at Guapiles, Costa Rica.

Corozal	Isabela	Guapiles
PREDOMINANT WEEDS		
Panicum maximum Jacq.	Ipomoea tiliacea Willd.	Digitaria sanguinalis (L.) Scop
Digitaria sanguinalis (L.) Scop.	Euphorbia heterophylla L.	Panicum fasciculatum SW
Urena lobata L.	Sorghum halepense L.	Paspalum conjugatum Bergins
Eleusine indica	Brachiaria purpurescens (Raddi Henr)	Melantera aspera (Jacqui) L.C.
Euphorbia heterophylla L.	Cenchrus echinatus L.	Momordica charantia L.
Echinocloa colonum (L.) Link.	Axonopus compressus (SW.)Beaw	Panicum trichoides Swartz.
Cynodon dactylon (L.) Pers.	Panicum maximum Jacq.	Eleusine indica L.
Commelina diffusa Burn. f.		Borreria laevis (Lam) Griesb
Momordica charantia L.		Phytollaca spp.
		Erechtites hieracifolia
		Paspalum paniculatum L.
OTHER WEED SPECIES		
Cyperus rotundus L.	Amaranthus dubius Mart.	Solanum nigrum
Mimosa pudica L.	Oxalis intermedia A. Rich	Phyllanthus niruri L.
Sida acuta Burn. F.	Desmodium tortuosum (SW) Dc.	Pennisetum purpureum
Phaseolus lathyroides L.		Ipomoea spp.
Emilia sonchifolia (L.) DC		Ochorona piramidale
Amaranthus dubius Mart.		Emilia sonchifolia (L.) Dc.
Oxalis martiana Zucc.		Mimosa pudica L.

TABLE 7. Total dry weight of weeds in the experiments at Isabela, Puerto Rico and Guapiles, Costa Rica.

Treatment	Isabela	Guapiles
	-------kg/ha-------	
Hand weeded for 4 weeks, free weed growth thereafter [1/]	1,900	5,106 a
" " " 8 " " " " "	870	2,219 bcd
" " " 10 " " " " "		1,432 cde
" " " 12 " " " " "	700	927 de
" " " 14 " " " " "		589 de
" " " 16 " " " " "	410	847 de
" " " 20 " " " " "	670	930 de
" " " 24 " " " " "	1,000	
the whole season		
Weed competition for 4 weeks, hand weeding thereafter [2/]	1,000	131 e
" " " 8 " " " " "	1,700	1,016 cde
" " " 10 " " " " "		1,445 cde
" " " 12 " " " " "	1,580	1,871 bcd
" " " 14 " " " " "		2,584 bc
" " " 16 " " " " "	3,030	2,002 bcd
" " " 20 " " " " "	4,170	3,039 b
" " " 24 " " " " "		
the whole season	-	4,450 a

[1/] Weed weights recorded at harvest.

[2/] Weed weights recorded at the first hand weeding.

at harvest in comparison to where hand weeding was carried out to the 4th week after planting (5106kg/ha). The high weed weights where weeding was carried out only to the 8th week from planting correspond to lower yields than where hand weeding was continued until the 10th week from planting.

DISCUSSION

The critical periods of weed competition are influenced by the genetic makeup of the crop, the environment, the weeds present during the different stages of crop growth, and the crop management practices. The genetic makeup determines the crop growth cycle, the requirements for nutrients, light, CO_2 and space. The environment, the weeds and the crop management practices have a direct influence on these crop requirements.

At Corozal and Isabela, the same species of yam (*D. rotundata*) was used. At Guapiles, a species with a somewhat different growth cycle (*D. alata*) was studied. The rainfall at both sites in Puerto Rico was approximately half of that in Costa Rica. The soil at Costa Rica was much more fertile than those in Puerto Rico. Crop management practices at the three sites were similar in that they corresponded to high input agriculture. The crop was well fertilized, staked, and practices were carried out to prevent damage from diseases, insects and nematodes. However, the planting distance was similar at Corozal and Guapiles, but much greater at Isabela. In spite of these differences, some trends may be observed among the experiments.

At Corozal, results indicated that the critical period of weed competition was prior to the 17th week after planting. Results at Isabela showed the critical period was between the 8th and the 12th week after planting, while at Guapiles, the critical interval was found between the 4th and the 10th week from planting.

The data from Isabela supports and complements that observed at Corozal, and the Guapiles data has the same effect on that from Corozal and Isabela. The hand weeding interval at Corozal were very long (10, 17, 22, 28 ands 37 weeks). At Isabela they were narrower (4, 8, 12, 16, 20 and 24 weeks), and at Guapiles still narrower (4, 8, 10, 12, 14, 16, 20 weeks and the whole season). Due to the long intervals at Corozal and to the age of the yam plant at the first hand weeding operation, it was not possible to determine whether weed competition had had an effect on yield prior to the 10th week from planting. Although it was determined that weed competition for more than 10 but less than 17 weeks had deleterious effect on yield, it could not be determined whether it was necessary to hand weed until the 11th, 12th, 14th week, or whether hand weeding operations had to be carried out until the 17th week in order to avoid yield losses.

The four week intervals between weedings at Isabela helped narrow down critical period found at Corozal. The Isabela sites showed that it ranged from the 8th until the 12th week from planting. Results indicated that it was not necessary to hand weed until the 17th week, for no differences in yield were found between hand weedings only until the 12th week from planting, and the treatment hand weeded throughout the season. No reductions in yield were found when weeds were allowed to compete during the first 8 weeks of crop growth, but yields were lowered if competition was allowed for a longer period at Isabela. Isabela data, once again, complements the Corozal data, where The damage due to weed competition for up to 10 weeks from planting could not be determined.

The data from Guapiles narrows even more the critical period found at Corozal and Isabela. No benefit was obtained from hand weeding for more than 10 weeks from planting. Therefore, it is not necessary to hand weed until the 12th week from planting as observed at Isabela.

At Guapiles, yields were reduced if competition was obtained for more than 4 weeks from planting. The data is in contrast to the one at Isabela where it was shown that weed competition could be allowed for up to 8 weeks from planting. The difference between the two experiments may probably be explained by a difference in the requirements of the species of yam studied. Weed weight at 8 weeks from planting were higher at Isabela than at Guapiles, so the differences in yield may not be explained by differences in weed pressure.

Definite conclusions on the critical periods of weed competition can not be made from only threee experiments. However, general trends may be observed for the species used, under similar environmental conditions, crop management practices and similar weed species. It was observed that no benefits are obtained for more than 10 weeks after planting. In Puerto Rico, there was no need to weed yams *(D. rotundata)* during the first 8 weeks of growth, while in Costa Rica, weeding was not necessary during the first 4 weeks, but was necessary prior to the 8th week from planting.

By allowing weed competition during the first eight weeks from planting, soil erosion may be greatly reduced in the sloping hills of Puerto Rico, if the crop was weeded during the same period. It is during this period that the rainy season begins on the land, leaving the soil exposed to severe erosion damage.

Costs of weeding yams have been reported as 35 per cent, 27 per cent, 24.8 per cent and 14.8 per cent of all costs of production (LYONGA, 1980; GONZALEZ et al, 1980; FERGUSON-RANKINE, 1974; OYOLU, 1978). By controlling weeds only in the six week interval between the 4th and the

10th week from planting in Costa Rica, or in the 8 to 10 week interval in Puerto Rico, the costs of producing yam could be greatly reduced.

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