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WEED POPULATION RESPONSES TO HERBICIDE-CROP ROTATIONS

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ABSTRACT

Yam (*Dioscorea*)is an important staple food throughout the Caribbean. Weed competition is a major limitation to production of yam crops. Because of reduced interest in herbicide registration for limited-acreage crops such as yam, farmers need alternative weed control methods. Herbicide-crop rotations may become an alternative strategy for weed control in crops such as yams. The objective of this study was to determine weed population responses and yam production under herbicide-crop rotations. A two year study was conducted at two locations. Treatments were:

- a) fallow-yam-yam,
- b)bean-bean-bean-yam,
- c) cabbage-cabbage-cabbage-yam,
- d) bean-cabbage-bean-yam and
- e) cabbage-bean-cabbage-yam.

Weed species were different at Coropal and Isabela. The former *Sorghum halepense* was reduced after the two-year herbicide-crop rotation but other weed densities were not different among treatments. At the latter, common weeds were *Echinochloa colona, Eleusine indica, Digitaria sanguinalis*, and *Amaranthus dubius*. At both locations weed densities were lower in the final yam planting than at the beginning of the study and no significant differences in tuber yields were detected among treatments. Data obtained in this study did not provide conclusive results, but dramatic changes in the *S. halepense* density demonstrate the potential of crop-herbicide rotation for the control of specific weeds.

INTRODUCTION

Yams (*Dioscorea.*) are an important staple food in Puerto Rico and throughout the Caribbean. Weed interference is a major limitation to production of yam crops. Season-long weed competition may reduce yam yields up to 47% (Liu *et al.*, 1994). Practices for weed control include combinations of pre- and post-emergence herbicides and manual weeding. Numbers of pre-emergence herbicides for use in tropical root and tuber crops are notably limited (Esta. Exp. Agric.-UPR, 1997). For example, ametryn is the only pre-emergence herbicide registered for use in yam; if it were withdrawn, farmers would have to resort to manual weeding for pre-emergence control.

Because of reduced interest in herbicide registration for limited-acreage crops such as yam, farmers need alternative management strategies for weed control. Under these circumstances, agronomic practices such as rotation or herbicide-crop rotation become alternatives for change in the conventional patterns of crop-weed competition.

Weeds are suppressed by crop rotation (Buchanan *et al.*, 1975; Johnson and Coble, 1986; Glaze *et al.*, 1984). Researchers have reported weed population shifts in rotational studies over several years (Coble and Schrader,

1974; Johnson and Coble, 1986; Glaze *et al.*, 1984). In a three-year herbicide-crop rotation study, Hauser *et al.* (1974) found the major change in population to be a reduction in yellow nutsedge (*Cyperus esculentus*). Unfortunately, most of the research related to crop rotation-herbicide sequence and their effects on weed composition have been conducted in temperate regions. It is essential to understand these relationships in tropical environments for the improvement of weed control programs throughout the Caribbean Basin.

In Puerto Rico, a study was conducted to determine weed population responses and yam yields under herbicide-crop rotations.

MATERIALS AND METHODS

The study was conducted between November 1995 and November 1997 at two locations, the Corozal and the Isabela Agricultural Experiment Substations of the University of Puerto Rico. The Corozal substation is located in the north-central region of the island where the soil is a Corozal clay (Aquic Haplohumults) with a pH of 5.8. The Isabela substation is in the northwest of the island. The soil there is a Coto clay (Typic Hapludox) with a pH of 6.2.

To determine the effect of vegetable herbicides on a tuber crop, yam was planted as the final crop in the rotation. Treatments were: **a**) fallow-yam-yam (y-y) (control), **b**) bean-bean-bean-yam (b-b-b-y), **c**) cabbage-cabbage-cabbage-yam (c-c-c-y), **d**) bean-cabbage-bean-yam (b-c-b-y), and **e**) cabbage-bean-cabbage-yam (c-b-c-y). Bean breeding line 9418-2 was planted 10 cm apart in rows spaced at 0.60 m. Seedlings of cabbage cv. Blue Vantage were transplanted 30 cm apart in rows spaced at 0.91 m. Yam cv. Diamante (*D. alata*) was planted at the same spacing as cabbage. At both locations, the treatments were arranged in a randomized complete block design with four replications.

In all bean plantings, trifluralin at 0.56 kg.ai/ha was incorporated pre-planting. Metolachlor (at 1.68 kg. ai/ha) as pre-emergence and sethoxydim (at 0.22 kg.ai/ha) as post-emergence were used only in the first bean planting. In cabbage, oxyfluorfen at 0.56 kg.ai/ha was used pre-emergence.

In the last yam planting of the y-y rotation, paraquat (POE, 0.56 kg.ai/ha) was applied a month after planting. Herbicide sequences were the same at both locations. Because of differences in weed species by location, yam required one hand weeding at Corozal and three weedings at Isabela.

Weed population (density and species composition) was determined before each herbicide application or hand weeding by sampling ten 0.25 m^2 random quadrats per plot. Yam yield data were recorded as fresh weight of the tuber. Data were statistically analyzed and means were compared by Least Significant Difference test at the 0.05 probability level.

RESULTS AND DISCUSSION

Weed species were different at the two locations, therefore statistical analyses were made by location. At the beginning of the study (1995), the most abundant weed at Isabela was *Sorghum halepense* with a density of 48 plants/m^2. Other weeds were *Digitaria sanguinalis*, *Cyperus rotundus*, and *Euphorbia heterophylla* having densities that ranged from 4 to 8 plants/m^2. *Sorghum halepense* was reduced by all treatments after the two-year herbicide-crop rotations. Its density was reduced to 7.8 plants/m^2 in the c-c-c-y rotation and to 8.3 plants/m^2 in the c-b-c-y rotation. The use of oxyfluorofen in cabbage cause suppression of *Syurghum helepense*.

Weed densities in the final yam planting, except for S. *halepense* and E. *heterophylla*, were not different among treatments (Table 1). The density of E. *heterophylla* was higher in the b-c-b-y rotation than in the other rotations (Table 1). In the final yam planting, *Eleusine indica* appeared as a weed. However, this weed was not common in 1995.

Table 1. Effect of herbicide-crop rotations on populations/density of common weeds at , Isabela, Puerto Rico.

Crop Rotations	no. plants/m2						
	Sorghum halepense	Digitaria sanguinalis	Eleusine indica	Echinochloa colona	Ricardia scabra	Euphorbia heterophylla	Amaranthus dubius
Y-Y[1]	17.2	5.6	0	1.0	5.1	7.8	0.8
B-B-B-Y	15.6	5.6	12.9	0.2	0.2	9.5	2.5
C-C-C-Y	7.8	10.1	4.1	0.4	2.1	9.3	2.2
B-C-B-Y	19.6	8.7	5.3	1.6	1.3	24.7	5.9
C-B-C-Y	8.3	2.1	2.0	2.7	0.3	3.8	2.1
LSD (0.05)	7.9	N.S.	N.S.	N.S.	N.S.	7.9	N.S.
Mean	13.7	6.42	4.8	1.18	1.8	11.0	2.7

[1] Y = Yam , cv. Diamante (Discorea alata).
B = Bean , breeding line 9418-2
C = Cabbage , cv. Blue Vantage

No significant differences were detected among treatments for yam yield (Table 3). Average yield was 11,406 kg/ha. The density of 13 plants /m^2 of S. *halepense* in combination with other weed species was high enough to cause interference to yam.

At Corozal, common weeds at the beginning of this study in 1995 were *Echinochloa colona, Eleusine indica*, D. *sanguinalis*, and *Amaranthus dubius* with densities of 76, 51, 33 and 19 plants/m^2, respectively. Weed densities were lower in the final yam planting than in 1995 (Table 2). At this location, *Portulaca oleracea* and *Lepidium virginicum* were common in the final yam planting. However, densities of these weeds were low in 1995. Similarly as for Isabela, at Corozal no significant differences in yam and tuber yields were detected among treatments. (Table 3). The yam yield at Corozal (24,086 kg/ha) was higher than that at Isabela.

Table 2. Effect of herbicide-crop rotations on population densities of common weeds at Corozal, Puerto Rico.

Crop rotations	plants/m^2				
	Digitaria sanguinalis	Eleusine indica	Echinochloa colonum	Portulaca oleracea	Lepidium virginicum
Y-Y[1]	9.9	3.5	21.9	7.7	6.3
B-B-B-Y	2.8	3.4	14.8	6.0	3.2
C-C-C-Y	3.1	1.6	18.9	7.3	5.6
B-C-B-Y	3.8	2.6	22.9	17.9	5.8
C-B-C-Y	3.8	3.2	20.3	8.0	6.3
LSD (0.05)	N.S.	N.S.	N.S.	N.S.	N.S.
Mean	4.68	2.86	19.76	9.38	5.54

[1] Y = Yam, cv. Diamante (Dioscorea alata).
B = Bean, breeding line 9418-2
C = Cabbage, cv. Blue Vantage.

Data obtained in this relatively short term study may not provide conclusive results. More than two years of study are required to establish the true effects of crop-herbicide rotation as alternative weed management strategies. Dramatic changes, however, occurred with *S. halepense* at Isabela when using cabbage as a previous crop. The above response demonstrates the potential of crop herbicide rotation for the control of a specific weed.

Table 3. Tuber production by yam plants after different crop herbicide rotations in trials at Corozal and Isabela, Puerto Rico. 1997.

Crop rotations	Corozal		Isabela	
	No./ha	kg/ha	No./ha	kg/ha
Y-Y[1]	13,756	30,901	13,662	7,309
B-B-B-Y	21,531	18,577	15,616	9,454
C-C-C-Y	20,136	21,839	26,414	19,603
B-C-B-Y	20,734	21,930	14,619	8,344
C-B-C-Y	29,107	27,186	17,443	12,323
LSD (0.05)	N.S.	N.S.	N.S.	N.S.

[1] Y = Yam, cv. Diamante (*Dioscoreo alata*).
B = Bean, breeding line 9418-2
C = Cabbage, cv. Blue Vantage

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