

# Weed control in sweet potato [*Ipomoea batatas* (L.) Lam.]<sup>1,2</sup>

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## ABSTRACT

A field study was conducted at Gurabo and Juana Díaz, Puerto Rico, to evaluate the use of plastic mulch and herbicide sequences as an alternative weed management for sweet potato [*Ipomoea batatas* (L.) Lam.]. Concurrently, efficacy of and tolerance to dimethenamid in sweet potato was assessed in the response of eight sweet potato lines to broadcast application of dimethenamid and clomazone herbicides. For the herbicide sequence, treatments were 1) plastic with paraquat at 0.56 kg ai/ha; 2) ametryn at 6 kg ai/ha with sethoxydim at 0.45 kg ai/ha; 3) clomazone at 1.12 kg ai/ha with sethoxydim at 0.45 kg ai/ha; 4) dimethenamid at 1.68 kg ai/ha with sethoxydim at 0.45 kg ai/ha; 5) clomazone at 1.12 kg ai/ha with clethodim at 0.11 kg ai/ha; and 6) clomazone at 1.12 kg ai/ha with clethodim at 0.22 kg ai/ha. Predominant weeds were junglerice (*Echinochloa colona*), purple nutsedge (*Cyperus rotundus*), spleen pigweed (*Amaranthus dubius*) and dayflower (*Commelina diffusa*). Herbicide treatment by location interaction was significant for yield. Yield was higher at Juana Díaz for all of the treatments except for that of plastic with paraquat. The use of dimethenamid followed by sethoxydim resulted in 9,614 kg/ha less sweet potato yield than with the use of clomazone followed by sethoxydim. At Gurabo, no significant difference was found among herbicide treatments for weed density and sweet potato yield. Neither crop injury nor phytotoxicity was observed when dimethenamid at 1.68 and 3.36 kg ai/ha was applied. Promising new lines of sweet potato tolerated clomazone, dimethenamid and clethodim.

Key words: herbicides, weed control, sweet potato

## RESUMEN

### Control de malezas en batata [*Ipomoea batatas* (L.) Lam.]

Se establecieron experimentos de campo con batata en Juana Díaz y Gurabo, Puerto Rico, para determinar alternativas de control de malezas utilizando cubierta plástica y secuencias de herbicidas. Al mismo tiempo este experimento proveyó datos sobre eficacia y fitotoxicidad de dimethenamid en batata y sobre la fitotoxicidad de dimethenamid y clomazone en nuevas líneas de batata. Los tratamientos en el experimento de secuencia de herbicidas fueron 1) plástico y paraquat a la dosis de 0.56 kg ia/ha; 2) ametryn a 6

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kg ia/ha y sethoxydim a 0.45 kg ia/ha; 3) clomazone a 1.12 kg ia/ha y sethoxydim a 0.45 kg ia/ha; 4) dimethenamid a 1.68 kg ia/ha y sethoxydim a 0.45 kg ia/ha; 5) clomazone a 1.12 kg ia/ha y clethodim a 0.11 kg ia/ha; y 6) clomazone a 1.12 kg ia/ha y clethodim a 0.22 kg ia/ha. Las malezas comunes fueron arrocillo (*Echinochloa colona*) y coquí (*Cyperus rotundus*), bleo (*Amaranthus dubius*) y cohítre (*Commelina diffusa*). La interacción tratamiento de herbicidas por localidad fue significativa para el parámetro de rendimiento de batata. En Juana Díaz, el rendimiento de batata fue mayor que en Gurabo en todos los tratamientos, excepto en el de plástico seguido por paraquat. Cuando se utilizó dimethenamid seguido por sethoxydim, el rendimiento fue 9,614 kg/ha menor que cuando se utilizó clomazone seguido por sethoxydim. En Gurabo, no se observaron diferencias en densidad de malezas ni en el rendimiento de batata con los herbicidas evaluados. Dimethenamid controló las malezas igual que el tratamiento de clomazone y no hubo diferencias en rendimiento de batata en ninguno de los tratamientos de herbicidas. En el experimento de líneas de batata no se observó fitotoxicidad por los herbicidas en ninguna de las líneas evaluadas.

Palabras clave: herbicidas, control de malezas, batata

## INTRODUCTION

In Puerto Rico, sweet potato [*Ipomoea batatas* (L.) Lam.] production during fiscal year 2004-05 was estimated at 3,612 t for a farm value of \$2.5 million (Dept. of Agric., 2006). Under the conditions of Puerto Rico, significant yield reduction is certain under less than adequate weed control. Semidey et al. (1987) determined 78 to 91% yield reduction resulting from the interference of 13 to 91 plants per square meter of spleen pigweed (*Amaranthus dubius*). Field observations have revealed that within the sweet potato crop cycle, farmers need to control weeds at least the first six weeks after the sweet potato establishment, the time when canopy closes under normal conditions. Because of the vining nature of sweet potato, and in order to avoid physical injury to plants, mechanical cultivation as a weed control practice is limited before canopy closure (Glaze and Hall, 1990; Seem et al., 2003). In Puerto Rico, the use of herbicide in combination with hand weeding is the most common practice for weed control. Herbicides registered for this crop are limited; clomazone and clethodim were registered recently. Clomazone is a preemergence herbicide that controls some grasses and broadleaves in sweet potato (Porter, 1990), whereas clethodim is a postemergence grass herbicide. Dimethenamid, a herbicide not registered for use in sweet potato provides excellent weed control in potato (*Solanum tuberosum*) and melons (*Cucumis melo*) (Umeda and Lund, 2001; Richardson, 2004) and can be evaluated for sweet potato. Research must be conducted to identify herbicides that improve weed control in this root crop.

The use of plastic mulch in combination with drip irrigation has effectively controlled weeds in sweet potato in the continental United

States, increasing yield while reducing production costs (Oregon State University, 2003). Because the use of plastic mulch is common for vegetable production throughout the southern coastal plains of Puerto Rico, its use for sweet potato appeared to be an alternative to alleviate production cost. In Puerto Rico limited research has been conducted using plastic mulch for weed control for tropical root crops (unpublished data)<sup>5</sup>. This study evaluated the use of plastic mulch and herbicide sequences as an alternative in weed management for sweet potato. Concurrently, we wanted to generate efficacy and tolerance data of dimethenamid in sweet potato and to assess the response of eight sweet potato lines to dimethenamid, clomazone and clethodim.

## MATERIALS AND METHODS

### *Herbicide treatments evaluation*

Field experiments with sweet potato were established at the Gurabo Substation of the Agricultural Experiment Station of the University of Puerto Rico in July 2002 and March 2003, and at Juana Díaz Substation in August 2002. At Gurabo the soil type is of the Mabí series (very-fine, mixed, active, isohyperthermic, Aquic Hapluderts). At Juana Díaz soil belongs to the San Antón series (fine-loamy, mixed, superactive, isohyperthermic Cumulic Haplustolls). Experimental plots consisted of four beds 6.09 m long and 1.5 m wide each. A promising sweet potato experimental line, No. 98-022, was used for all assays and planted 46 cm apart, on top of the beds. For the purposes of this study the cultivar (or experimental line) was considered a random effect. Treatments were evaluated in a randomized complete block design with four replicates. All plots were drip irrigated as needed. Treatments during 2002 at Gurabo and Juana Díaz were 1) plastic and paraquat at 0.56 kg ai/ha applied postemergence (POE); 2) ametryn at 6 kg ai/ha applied preemergence (PRE) followed by (fb) sethoxydim at 0.45 kg ai/ha POE; 3) clomazone at 1.12 kg ai/ha PRE fb sethoxydim at 0.45 kg ai/ha POE; 4) dimethenamid at 1.68 kg ai/ha PRE fb sethoxydim at 0.45 kg ai/ha POE; 5) clomazone 1.12 kg/ha PRE fb clethodim at 0.11 kg ai/ha POE; and 6) clomazone 1.12 kg/ha PRE fb clethodim at 0.22 kg ai/ha POE.

Treatments in 2003 at Gurabo were 1) plastic and paraquat at 0.56 kg ai/ha applied postemergence (POE); 2) ametryn at 6 kg ai/ha applied preemergence (PRE) fb clethodim at 0.11 kg ai/ha POE; 3) clomazone at 1.12 kg ai/ha PRE fb clethodim at 0.11 kg ai/ha POE; 4) clomazone

<sup>5</sup>Rivera, L. E. and A. González, 2003. Niveles de riego y cubierta plástica en la producción de ñame (*Dioscorea alata* cv. Diamante) en la costa sur de Puerto Rico. Abstract Soc. Puertorriqueña de Ciencias Agrícolas. Annual Meeting, 2003.

1.12 kg/ha PRE fb clethodim at 0.22 kg ai/ha POE; and 5) dimethenamid at 1.68 kg ai/ha PRE fb clethodim at 0.11 kg ai/ha POE.

Preemergence herbicides were applied one day after sweet potato planting with a portable CO<sub>2</sub>-pressured backpack sprayer, delivering 187 L/ha. Each plant was side dressed with 85 g of fertilizer having a formulation of 12-5-15-3, applied three weeks after planting. Weed control rating or weed density was recorded four weeks after PRE herbicide applications. Weed density was estimated from four randomly placed quadrants (0.093 m<sup>2</sup>) in each plot. Visual rating for crop injury was recorded four weeks after PRE herbicide applications. Weed control was determined on a scale from 0 to 100, where 0 means no control and 100 means complete weed control. Hand hoeing was done once in plots with preemergence herbicides, whereas two weedings were made between plastic mulch beds. Sethoxydim or clethodim was applied two months after planting. Five months after planting, the two middle rows of each plot were harvested by hand. Roots were classified as marketable and nonmarketable. The marketable roots were counted and weighed and total yield was determined. Data on weed density or weed control, crop injury and yield were analyzed and treatment means separated by a Fisher's protected LSD ( $P < 0.05$ ).

#### *Evaluation of Sweet Potato Lines*

A screening test was conducted to assess the response of eight sweet potato experimental lines to clomazone, dimethenamid and clethodim. The experiment was established at Gurabo in May 2002. Experimental plots consisted of 6.09-m × 1.52-m beds laid out as strip plots. Experimental sweet potato lines assessed were 97-031, 97-045, 98-022, 98-023, 97-033, 98-039, 98-040 and Martina. Preemergence herbicide treatments were dimethenamid at 1.68 and 3.36 kg ai/ha; and clomazone at 1.12 and 2.24 kg ai/ha. Herbicides were applied over the top of beds one day after planting. Weed control and crop injury rating were recorded four weeks after herbicide application. Clethodim at the rate of 0.22 kg ai/ha was applied on the entire plot seven weeks after planting. A second crop injury evaluation was made four weeks after clethodim application.

## RESULTS AND DISCUSSION

#### *Herbicide Treatment Evaluation*

The average rainfall at Juana Díaz (2002) during the five-month crop cycle was 57 mm whereas at Gurabo it was 120 mm. During the 2003 crop cycle at the Gurabo substation average rainfall was 161 mm.

At both locations, predominant weeds (among grasses and Cyperaceae) were junglerice (*Echinochloa colona*) and purple nutsedge (*Cyperus rotundus*). At Juana Díaz spleen pigweed (*Amaranthus dubius*) was the predominant broadleaf, whereas at Gurabo, dayflower (*Commelina diffusa*) was the most common non grass species. For the 2002 experiment, no differences were obtained among treatments for weed density at either location (Table 1). Similar results for weed density were reported by Lugo-Torres et al. (2006) at Juana Díaz for a yam experiment.

In 2002, herbicide treatment by location interaction was significant for yield. Yield was higher at Juana Díaz for most of the treatments, except for the plastic fb paraquat treatment (Table 1). At Gurabo, no yield differences were obtained among herbicide treatments; yield averaged 21,145 kg/ha (Table 1). Average yield at Juana Díaz was 33,803 kg/ha, which is considered within the expected range of yield for sweet potato. In Puerto Rico, yields of many crops are usually higher in the southern coastal valleys, where the Juana Díaz Substation is located. These re-

TABLE 1.—Effect of herbicide sequence on weed density and sweet potato yield in Juana Díaz and Gurabo, 2002.

Treatment	Rate (kg ai/ha)	Weed density <sup>1</sup> (no/m <sup>2</sup> )		Sweet potato yield (kg/ha)	
		Juana Díaz	Gurabo	Juana Díaz	Gurabo
plastic fb <sup>2</sup> paraquat	0.56 POE	0	0	22,854	25,327
ametryn fb sethoxydim	6.0 PRE fb 0.45 POE	9	21	34,975	20,502
clomazone fb sethoxydim	1.12 PRE fb 0.45 POE	20	32	41,393	18,753
dimethenamid fb sethoxydim	1.68 PRE fb 0.45 POE	46	7	31,779	20,804
clomazone fb clethodim	1.12 PRE fb 0.11 POE	42	30	40,281	22,432
clomazone fb clethodim	1.12 PRE fb 0.22 POE	8	23	31,538	19,055
LSD (0.05)		ns	ns	9,190	

<sup>1</sup>Weed density was determined four weeks after herbicide application. Weed species at Juana Díaz were *Amaranthus dubius* (44%), *Cyperus* spp. (33%), *Echinochloa colona* (14%), *Cleome gynandra* (5%), *Portulaca oleracea* (3%), and *Urochloa subquadriflora* (1%); and at Gurabo, weed species were *Commelina diffusa* (42%), *Echinochloa colona* (15%), *Ipomoea* spp. (13%), *Cleome gynandra* (11%), *Phyllanthus niruri* (11%) *Boreria ocymoides* (6%) and *Cyperus* spp. (2%).

<sup>2</sup>fb means followed by; POE = postemergence and PRE = pre-emergence.

sponses have been associated with increased level of fertility in the soil and reduced incidence of pests as compared to that of the central mountainous region (Ortiz et al., 1998; Irizarry et al., 1989; Martin, 1987).

In the 2003 experiment at Gurabo, all herbicide treatments evaluated controlled more than 96% of weeds, and no significant differences were obtained among treatments for weed density (Table 2). No significant differences for yield among herbicide sequence were obtained (Table 2). These results are in accord with the high percentage of weed control and low weed density in all treatments. Average sweet potato yield was 16,301 kg/ha. Yield under plastic mulch was not significantly different from that under the conventional planting system (no plastic mulch). In this experiment plots with dimethenamid had the same yield as the plots where other registered herbicides were used. Further evaluations, however, must consider cost of use of herbicide as compared to that of plastic mulch and other standard weed control practices.

#### *Evaluation of Sweet Potato Lines*

Neither crop injury nor phytotoxicity was observed when dimethenamid at the rate of 1.68 and 3.36 kg ai/ha, or clomazone at the rate of 1.12, and 2.24 kg ai/ha were applied preemergence in the eight experimental lines of sweet potato. The same outcome was observed for the postemergence treatment of clethodim at the rate of 0.22 kg ai/ha. Lines 98-040 and 98-022, the most promising lines for Puerto Rico among those included in the test, tolerated this type of management, with yields of 21,108 and 19,278 kg/ha, respectively. Results of these

TABLE 2.—*Effect of herbicide sequence on weed control, weed density and sweet potato yield in Gurabo, 2003.*

Treatment	Rate (kg ai/ha)	Control <sup>1</sup> (%)	Weed density (no/m <sup>2</sup> )	Sweet potato yield (kg/ha)
Plastic fb paraquat	0.56 POE	100	0	23,123
ametryn fb clethodim	6.00 PRE fb 0.11 POE	96	11	15,618
clomazone fb clethodim	1.12 PRE fb 0.11 POE	98	3	14,459
clomazone fb clethodim	1.12 PRE fb 0.22 POE	98	7	15,984
dimethenamid fb clethodim	1.68 PRE fb 0.11 POE	98	7	12,324
LSD (0.05)		2	ns	ns

<sup>1</sup>Control and weed density was determined four weeks after herbicide application; weed species were *Echinochloa colona* (48%), *Phyllanthus niruri* (27%), *Cyperus* spp. (17%), *Cleome gynandra* (4%), *Chamaesyce* spp. (2%) and *Ipomoea* spp. (2%).

<sup>2</sup>fb means followed by.

studies indicate that dimethenamid (trial herbicide) is effective on annual weeds and might be included as part of a weed control program for sweet potato under the conditions of Gurabo, Puerto Rico.

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