Herbicide Screening Trials on Yams (*Dioscorea* sp.)[1]

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ABSTRACT

Two field trials were conducted during 1979–1980 on a Corozal clay (Ultisol) and a Coto clay (Oxisol) to screen promising herbicides for weed control on yams. In one experiment, Ametryn at 2.24, 4.48 and 8.96 kg/ha, Nitrofen at 6.72, 13.44 and 26.88 kg/ha, Paraquat at 2.34, 4.68 and 9.36 l/ha and Prometryn at 2.24, 4.48 and 8.96 kg/ha were tested. In another experiment, Ametryn at 2.24, 4.48 and 8.96 kg/ha, Cryanazine at 4.48, 8.96 and 17.92 kg/ha, Diphenamid at 11.2, 22.4 and 44.8 kg/ha and Trifluralin at 2.34, 4.68 and 9.36 l/ha were applied. Ametryn or Prometryn at 4.48 kg/ha rate or Nitrofen at 6.72 kg/ha gave good preemergence weed control in one experiment. Paraquat applied postemergently gave best weed control performance of the four herbicides tested. Cyanazine at 4.48 kg/ha was ineffective at lower rates but the same herbicide at the medium rate of 8.96 kg/ha or above gave as good weed control as Ametryn at 4.48 or 8.96 kg/ha in experiment 2. Diphenamid and Trifluralin were ineffective against broadleaf weed species at their recommended rates of application.

INTRODUCTION

Yams (*Dioscorea* spp.) is the most important starchy root crop in Puerto Rico. In 1978–79, the production of yams reached 14,152 metric tons with a farm cash value of 6.1 million dollars (3). One of the major factors limiting yam production has been the high cost of labor to combat weeds. According to González-Villafañe et al. (6) manual weeding amounts to 27% of total yam production cost. The same study indicated that chemical weed control is not widely used by local farmers. Consequently, it is possible to reduce production cost through increased herbicide usage.

The status of weed control research in tropical root and tuber crops was reviewed by Moody in 1974 (10). Although the literature pertaining to the chemical weed control in yams has been extensive (1, 2, 4, 7, 8, 9), the only locally published work is that of Caro et al. (5). They reported that Simazine at 9 kg/ha, either in single preemergence application or as a split application, gave excellent weed control in yams. Two herbicide screening experiments on yams were conducted at the Corozal and Isabela Substations during 1978 and 1979 in an attempt to generate data on the efficacy and phytotoxicity of 2-(ethylamino)-4-(isopropylamino)-6-(methylthio)-s-triazine (Ametryn); 2,4-dichlorophenyl-p-nitrophenyl ether (Nitrofen); 1,1′-dimethyl-4,4′-dipyridinium ion (Parquat); 2,4-bis(isopro-

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pylamino)-6-(methylthio)-s-triazine (Prometryn); 2-[4 chloro-6-(ethylamino)-s-triazine-2-yl) amino]-2-methyl propionitrile (Cyanazine); N,N-dimethyl-2,2-diphenylacetamide (Diphenamide) and α,α,α-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine (Trifluralin) for registration purpose. This paper presents the results obtained from the two herbicide experiments.

MATERIALS AND METHODS

EXPERIMENT 1

The experiment was established on a Corozal clay (pH 5.9 and organic matter 3.5%) at the Corozal Substation. A randomized complete block design with four replications was used. The individual plots consisted of four rows 4.6 m long spaced with 1.1 m between rows. The planting distance between the plants was 0.6 m. Yam cultivar Guinea Blanco (*Dioscorea rotundata*) was planted April 12, 1979. The preemergence herbicide applications of Ametryn (Evik 80 W)[3], Nitrofen (Tok E-25 2 lb/gal) and Prometryn (Caparol 80 W) were applied broadcast with a portable sprayer at a volume of 281 l/ha and a pressure of 2.1 kg/cm^2. Postemergence applications of Paraquat (Gramoxone CL 2 lb/gal) were made May 25, 1979, and July 1979. A knapsack sprayer was used to direct the Paraquat to weeds only, at a volume of 468 l/ha. Weed control and phytotoxicity evaluations were made twice during the first 3 months with the exception of the Paraquat. Paraquat was evaluated at a later date. Crop management practices followed local farming procedures. One supplementary handweeding was required during the latter part of the growing season because of the rapid dissipation of preemergence herbicide activity in the soil. The yam tubers were harvested January 3, 1980, and yield recorded. Table 1 shows the average of two evaluation dates.

EXPERIMENT 2

The second experiment was established on a Coto clay soil at the Isabela Substation. The same yam cultivar Guinea Blanco was planted March 23, 1979. A randomized complete block design with four replications was used. Individual plots consisted of four rows 6.1 m long spaced at 1.2 m. The planting distance was 0.6 m. Preemergence applications of Ametryn (Evik 80 W), Diphenamid (Dymid 80 W) and Trifluralin (4 lb/gal) were made March 26, 1979. The Trifluralin treated plots were incorporated with a hand rake immediately following its application.

[3] Trade names in this publication are used only to provide specific information. Mention of a trade name does not constitute a warranty of equipment or materials by the Agricultural Experiment Station of the University of Puerto Rico, nor is this mention a statement of preference over other equipment or materials.

TABLE 1.—*Weed control ratings, phytotoxicity evaluations and tuber production for different herbicide treatments in the yam experiment at the Corozal Substation (1978-79)*

Herbicide treatments	Weed control ratings at[1]			Phytotoxicity evaluations at[2]			Tuber production
	6-14-79	7-26-79	Average	6-14-79	7-26-79	Average	
							Kg/ha
Ametryn—2.24 kg/ha	64	29	47	0	0	0	21,473 a[3]
Ametryn—4.48 kg/ha	88	60	74	5	0	3	24,637 a
Ametryn—8.96 kg/ha	91	73	82	10	0	5	21,006 a
Nitrofen—6.72 kg/ha	87	73	80	0	0	0	23,288 a
Nitrofen—13.44 kg/ha	87	78	83	0	0	0	21,317 a
Nitrofen—26.88 kg/ha	86	76	81	0	0	0	21,733 a
Paraquat—2.34 1/ha	93	84	89	3	0	2	23,807 a
Paraquat—4.68 1/ha	93	85	89	4	0	2	25,364 a
Paraquat—9.36 1/ha	96	90	93	10	0	5	20,540 a
Prometryn—2.24 kg/ha	73	36	55	0	0	0	23,184 a
Prometryn—4.48 kg/ha	85	63	74	5	0	3	24,170 a
Prometryn—8.96 kg/ha	89	66	78	8	0	4	21,370 a
Weeded check	95	95	95	0	0	0	20,280 a
Non-weeded check	0	0	0	0	0	0	14,679 b

[1] Weed control rating is based on a scale of 0-100; 0 = no control; 100 = complete control.

[2] Phytotoxicity evaluation is based on a scale of 0-100; 0 = no phytotoxicity; 100 = completely affected. Each value is the average of four replicates.

[3] Values in columns followed by the same letters do not differ statistically at the 5% probability level.

Preemergence application of Cyanazine (Bladex 80 W) was performed a week later. The first Paraquat application was made May 25, 1979, and the second July 26, 1979. Yam plants were staked 1 month after their germination. Weed control and phytotoxicity evaluation were made visually at approximately 1.5 and 2.5 months after treatment. There was one supplementary handweeding of all experimental plots, except the nonweeded check, during the latter part of the growing season. The yams were harvested January 23, 1980, and yields recorded. Table 2 shows the average of four replications at two evaluation dates.

RESULTS AND DISCUSSION

EXPERIMENT 1

The predominant weed species in the plots are listed in order of abundance: goose grass (*Eleusine indica* (L.) Gaertn.), Bermuda grass (*Cynodon dactylon* (L.) Pers.), niruri (*Phyllanthus niruri* L.), scarlet bean (*Phaseolus lathyroides* L.), caesarweed (*Urena lobata* L.), crabgrass (*Digitaria sanguinalis* (L.) Scop.), pigweed (*Amaranthus dubius* Mart.), spreading dayflower (*Commelina diffusa* Burn. f.), sensitive plant (*Mimosa pudica* L.), southern sida (*Sida acuta* Burn. f.), creeping woodsorrel (*Oxalis corniculata* L.), little ironweed (*Veronia cinerea* (L.) Less), spurge (*Euphorbia heterophylla* L.) and purple nutsedge (*Cyperus rotundus* L.). Ametryn and Prometryn at 2.24 kg/ha did not give adequate control of the above-mentioned weeds (table 1). Both herbicides at 4.48 kg/ha provided satisfactory weed control for about 6 to 8 weeks. Excellent weed control was achieved by further increasing Ametryn and Prometryn rates to 8.96 kg/ha. In a previous experiment, it was reported that Ametryn had given good weed control in yams (2). Nitrofen at a 6.72 kg/ha rate gave good weed control for about 2 months. Higher Nitrofen rates did not improve weed control beyond that achieved by the 6.72 kg/ha rate. Nitrofen had also provided excellent weed control in taro (*Colocasia esculenta* (L.) Schott.) as reported by Plucknett et al. (11). Paraquat, applied postemergent at 2.34 and 4.68 l/ha rates, gave good weed control for about 1 month. A second postemergence application was needed to control weeds. Weeds were further controlled as the rate of Paraquat was increased to 9.36 l/ha rate. Bermuda grass, scarlet bean and sensitive plant were troublesome weeds not completely controlled by Paraquat. Purple nutsedge was a noxious weed not completely controlled by Ametryn, Prometryn or Nitrofen.

None of the herbicides at the lower rates caused yam injury with the exception of Paraquat (table 1). Yam injury by Paraquat was due to drifting. The injury was present on the foliage in form of leaf chlorosis and necrosis. Paraquat at the rate of 9.36 l/ha did cause slightly more

TABLE 2.—*Weed control ratings, phytotoxicity evaluations and tuber production for different herbicide treatments in the yam experiment at the Isabela Substation (1978-79)*

Herbicide treatments	Weed control ratings at[1]			Phytotoxicity evaluations at[2]			Tuber production
	5-7-79	6-9-79	Average	5-7-79	6-9-79	Average	*Kg/ha*
Ametryn—2.24 kg/ha	30	14	22	0	0	0	14,060 b[3]
Ametryn—4.48 kg/ha	63	40	52	0	0	0	12,412 bc
Ametryn—8.96 kg/ha	66	41	54	0	0	0	11,966 bc
Cyanazine—4.48 kg/ha	43	28	36	0	0	0	9,721 bcde
Cyanazine—8.96 kg/ha	60	38	49	0	0	0	10,284 bcd
Cyanazine—17.92 kg/ha	96	65	81	0	0	0	13,908 b
Diphenamid—11.2 kg/ha	59	14	37	0	0	0	7,753 de
Diphenamid—22.4 kg/ha	64	20	42	0	0	0	5,819 def
Diphenamid—44.8 kg/ha	68	24	46	0	0	0	11,605 bc
Trifluralin—2.34 l/ha	55	16	36	0	0	0	8,224 cde
Trifluralin—4.68 l/ha	29	19	24	0	0	0	8,224 cde
Trifluralin—9.36 l/ha	54	23	39	0	0	0	10,343 bc
Weeded check	95	90	93	0	0	0	20,048 a
Non-weeded check	0	0	0	0	0	0	3,254 f

[1] Weed control rating is based on a scale of 0-100; 0 = no control; 100 = complete control.

[2] Phytotoxicity evaluation is based on a scale of 0-100; 0 = phytotoxicity; 100 = completely affected. Each value is the average of four replicates.

[3] Values in columns followed by the same letters do not differ statistically at the 5% probability level.

injury to yams. However, plants recovered rapidly and no death occurred. Slight leaf chlorosis also appeared in yams treated with Ametryn and Prometryn at their highest rate of 8.96 l/ha. Again, the injury was later outgrown. Nitrofen was highly selective to yams with no visible injury to plants.

Paraquat at the 4.68 l/ha rate produced the highest tuber yield of all herbicide treatments. Ametryn at 4.48 kg/ha rate and Prometryn at 4.48 kg/ha rate followed closely. Nitrofen at 6.72 kg/ha rate ranked fourth in yield. As the rates of Ametryn and Prometryn were further increased yam yield decreased somewhat. Similar yield decreases were observed for Paraquat and Nitrofen. With the exception of the nonweeded check, there were no significant yield differences among the various herbicide treatments.

EXPERIMENT 2

The predominant weed species in the plots are listed in their decreasing order of abundance: pigweed (*Amaranthus dubius* Mart.), spurge (*Euphorbia heterophylla* L.), morning glory (*Ipomoea tiliaceae* (Willd.) Choisy), spreading dayflower (*Commelina diffusa* Burn. f.), sicklepod (*Cassia tora* L.), para grass (*Braccharia purpurascens* (Raddi) Henr.), Bermuda grass (*Cynodon dactylon* (L.) Pers.), lion's ear (*Leonotis nepetifolia* (L.) R.Br.), purple nutsedge (*Cyperus rotundus* L.) and southern sandbur (*Cenchrus echinatus* L). Cyanazine at 17.92 kg/ha rate gave the best weed control of all the herbicide treatments (table 2). With the same herbicide at 4.48 kg/ha weed control was unsatisfactory. The plots treated with Cyanazine at the lowest rate failed to give adequate grass control after 6 weeks. It appears that Cyanazine requires a minimum rate of 8.96 kg/ha to be effective for controlling grassy weeds. The high rainfall and temperature prevailing during the experimental period may have caused Cyanazine to disappear at a fast rate. Consequently, higher rates of Cyanazine would be required to compensate for its rapid dissipation. Ametryn at 2.24 kg/ha rate was ineffective in controlling major weeds. Ametryn at the two higher rates tested gave good weed control for 6 weeks. This herbicide should be supplemented with a postemergent herbicide such as Paraquat to give sustained weed control. Diphenamid and Trifluralin were more effective against grasses but ineffective against a large number of broadleaf species. Weed population in plots treated with Diphenamid and Trifluralin shifted from grass species to broadleaf weeds. Higher rates of Diphenamid and Trifluralin did not control weeds effectively.

No herbicides, regardless of their rates of application, caused any yam injury at the Isabela Substation (table 2). In some instances leaf chlorosis was observed. Brief drought conditions that occurred during the latter part of the growing season may have caused this abnormal yellowing of the yam plants in both treated and check plots.

The highest tuber yield was obtained in the weeded check (table 2). It was then followed by the lowest rate of Ametryn at 2.24 kg/ha. Ametryn at 4.48 and 8.96 kg/ha resulted in somewhat lower yields, but the yield difference was not statistically significant. Cyanazine at the rate of 17.92 ranked third in yield. The same herbicide at lower rates resulted in lower yield than at its higher rate, but the yield difference was not statistically significant. Diphenamid and Trifluralin at their lower rates produced a considerably lower yield than the weeded check. Increasing the rate of Diphenamid and Trifluralin improved tuber production. For environmental and economic reasons, it does not seem feasible to use such a high rate. The non-weeded check, as expected, produced the lowest tuber yield, amounting to only 16% that of the weeded check.

The findings from the experiments reported indicate that a single preemergent herbicide application will not provide the long term weed control required by yams. In order to prolong weed control, it seems logical to use either Ametryn, Nitrofen, or Cyanazine as a preemergent herbicide followed by Paraquat as a postemergent application. At the present time, no one of the above-mentioned herbicides has received the federal use permit required by EPA. However, the Agricultural Experiment Station is actively working toward evaluation of these chemicals for possible registration.

RESUMEN

En 1978-79 la producción de ñame generó un ingreso de $6.1 millones. Debido a la importancia de este cultivo y al alto costo de la mano de obra se establecieron dos experimentos en un suelo Ultisol de Corozal y uno Oxisol en las Subestaciones de Corozal e Isabela, respectivamente, para evaluar la eficacia de varios herbicidas en el control de yerbajos en el ñame. En el primero, se aplicó Ametryne a 2.24, 4.68 y. 8.96 kg/ha; Nitrofen a 6.72, 13.44 y 26.88 kg/ha; Paraquat a 2.34, 4.68 y 9.36 l/ha; y Prometryne a 2.24, 4.48 y 8.96 kg/ha. En el segundo, se aplicó Ametryne a 2.24, 4.68 y 8.96 kg/ha; Cyanazine a 4.48, 8.96 y 17.92 kg/ha; Diphenamid a 11.2, 22.4 y 44.8 kg/ha y Trifluralin a 2.34, 4.68 y 9.36 l/ha. Todos los yerbicidas, excepto el Paraquat, se aplicaron con bomba de mochila a razón de 281 l/ha. Las aspersiones con Paraquat se aplicaron directamente sobre el follaje de los yerbajos a razón de 468 l/ha. Ametryne y Prometryne a 4.48 kg/ha y Nitrofen a 6.72 kg/ha fueron igualmente eficaces en el control preemergente de yerbajos. Paraquat aplicado solo como posemergente fue el mejor de los cuatro. Cyanazine no fue eficaz a dosis bajas pero sí cuando éstas se aumentaron. Diphenamide y Trifluralin no fueron efi-

caces contra los yerbajos de hoja ancha cuando éstos se aplicaron a las dosis recomendadas por los fabricantes para otros cultivos. Los herbicidas usados en estos experimentos no tienen a la fecha permiso de uso para el ñame; sin embargo, la Estación Experimental está haciendo las evaluaciones pertinentes para el posible registro en este cultivo por la Agencia de Protección Ambiental.

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