caribbean food crops society

17

Seventeen Annual Meeting

November 1981

VENEZUELA

Vol. XVII

PARAQUAT FOR WEED CONTROL IN TWO TROPICAL ROOT CROPS

Lii-Chyuan Liu, Edwin Acevedo-Borrero, José J. Green-Ortiz,
Miguel A. Santiago-Córdova, and Rafael Montalvo-Zapata

Agricultural Experiment Station, University of Puerto Rico, Mayaguez Campus

SUMMARY

Postemergence application of paraquat (1,1'-dimethyl-4,4'-bispyridinium ion) at the rates of 0.56, 1.12 and 2.24 kg ai/ha for weed control in taniers (Xanthosoma spp.) and yams (Dioscorea spp.) were evaluated at the Corozal and Isabela Substations. All the experiments were carried out on small plots arranged in randomized complete block designs with four replications. Weed control ratings and phytotoxicity evaluations were made periodically. The edible tubers were harvested and yield data analyzed statistically. Samples of edible tubers of yams were collected for herbicide residue determination and analyzed chemically.

In taniers, three postemergence applications of paraquat at 0.56 kg ai/ha gave good to excellent season-long weed control. Crop injuries caused by directed paraquat spray at lower rates were minor and the plants recovered rapidly. Injury was slightly aggravated with the increased rate of paraquat application. The highest tuber yield was obtained when paraquat was applied at 1.12 kg ai/ha followed by the 0.56 kg ai/ha rate. Paraquat at 2.24 kg ai/ha rate did not differ significantly from that of the weeded check.

In yams, paraquat at 0.56 kg ai/ha rate again showed a highly promising result on weed control. Injury caused by paraquat drift was of minor importance. In general, yams appeared to be slightly more tolerant to paraquat than taniers. Increased rate of paraquat improved slightly weed control, but aggravated the injury. Plots treated with paraquat at 0.56 kg ai/ha outyielded all other plots including the weeded check.

The paraquat residue recovered from edible tubers of yams ranged from 0.01 ppm to a level below the detection limit.

INTRODUCTION

Yams (Dioscorea spp.) and taniers (Xanthosoma spp.) rank first and second in economic importance among root crops in Puerto Rico. In 1979-80, yams and taniers contributed 7.6 and 6.5 million dollars respectively to the economy of the Island (1). One of the major factors limiting yam and tanier production has been the scarcity and high cost of labor needed to control weeds. As both crops have a long cycle of growing season, repeated postemergence herbicide applications are required to keep the weeds under control. Paraquat (1,1'-dimethyl-4,4'-bispyridinium ion) commercially known as Gramoxone is registered for use as postemergence weed control in a large number of crops in the United States (2). In Puerto Rico, the use of paraquat for weed control in yams and taniers has not been authorized. More information on the efficacy and phytotoxicity of paraquat in these two root crops as well as its effect on yield and residue level present in the edible tubers are needed for attaining registration. This paper summarizes the research efforts made during the past two years toward this end.

METHOD AND MATERIALS

Yams experiment

This experiment was established on a Corozal clay (an Ultisol, pH 6.0 and organic matter 3.5%) at the Corozal Substation. The individual plots consisted of four 6.1 m long rows spaced at 1.2 m between rows. The planting distance between plants was 0.6 m. Yam cultivar Guinea (Dioscorea rotundata L.) was planted mid April 1979. Fertilizer 8-8-13 was applied once at the rate of 60 grams per plant. A randomized complete block design with four replications was used. Postemergence application of paraquat at the rates of 0.56, 1.12 and 2.24 kg ai/ha was made twice at approximately six weeks' intervals after initial planting. A

knapsack sprayer was used to direct the paraquat spray to weeds only at a volume of 468 l/ha. Weed control ratings and phytotoxicity evaluation were made after each application. All pesticide managements followed the commercial practices for the region. The tuber yield was harvested January 3, 1981.

Randomized samplings of 3 kgs of yam tubers were made from each replication. The tubers were cleaned with tap water, cut with knives into small pieces and stored in a walking-in freezer. Later the samples were shipped in dry ice to Richmond, California for residue analysis. At the time of analysis, samples from 1st and 2nd replicates were composited into one and those of 3rd and 4th replicates into another. Each final aliquot for paraquat residue analysis represented 20 grams by weight of edible tubers. Paraquat residues were analyzed following sodium dithionite reduction colorimetric method as described by Zweig (4). Standard samples were fortified at the 0.05 ppm level and analyzed. The limit of detection of this method was 0.01 ppm.

Tanier experiment

This experiment was established on a Coto clay (an Oxisol, pH 6.9 and organic matter 2.6%) at the Isabela Substation. The individual plots consisted of four 6.1 m long spaced at 0.9 m between row. The planting distance was 0.6 m between the plants. Tanier cultivar Blanca (Xanthosoma sagittifolium L.) was planted to the field in May 30, 1979. Fertilizer 8-8-13 was applied once at the rate equivalent to 1,121 kg/ha six weeks after planting.

A randomized complete block design with four replications was used. Post-emergence applications of paraquat at the rates of 0.56, 1.12 and 2.24 kg ai/ha were made thrice using a knapsack sprayer at a volume of 468 l/ha. Weed control ratings and phytotoxicity evaluations were made periodically. All pesticide managements followed the commercial practices for the region. The marketable tubers were harvested April 21, 1980.

RESULTS

Yams experiment

The predominant weed species present in the plots are listed in their decreasing order of abundance; goose grass (Eleusine indica (L.) Gaertn.), Bermuda grass (Cynodon dactylon (L.) Pers.), scarlet bean (Phaseolus lathyroides L.), crabgrass (Digitaria sanguinalis (L.) Scop.), niruri (Phyllanthus niruri L.), 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.), caesarweed (Urena lobata L.), little ironweed (Veronia cinerea (L.) Less.), spurge (Euphorbia heterophylla L.), and purple nutsedge (Cyperus rotundus L.). Paraquat at 0.56 kg ai/ha gave good to excellent control of the above-mentioned weeds for about one month (table 1). Bermuda grass, scarlet bean, and sensitive plant were the troublesome weeds not completely controlled by the first application of paraquat at 0.56 kg ai/ha rate. A second application of paraquat was needed to keep these weeds under control. Increasing paraquat to 2.24 kg ai/ha rate improved slightly weed control.

The yam injury caused by paraquat was chiefly due to drift effect. Paraquat at 0.56 kg ai/ha rate caused only minor necrotic spots on leaves of the yam plants. The injury was recovered rapidly and seldom caused the death of the plants. As the concentration of paraquat was raised to 2.24 kg ai/ha crop injury was aggravated and in some instances death of yam plants occurred.

Paraquat at 1.12 kg ai/ha produced the highest tuber yield of all herbicide treatments followed by paraquat at 0.56 kg ai/ha rate (table 1). Paraquat at 2.24 kg ai/ha rate ranked third in tuber production and weeded check fourth. The above yield differences were not statistically significant. The only significantly lower tuber yield was obtained with non-weeded check.

The percentage of paraquat recovery on fortified samples was above 80. Paraquat residue found in the edible tubers ranged from 0 to 0.01 ppm (table 3). The limit of detection for the colorimetric method used as 0.01 ppm. Apparently, practically no paraquat residues detected in all the samples collected.

Taniers experiment

The predominant weed species present in the plots are listed in their decreasing order of abundance; pigweed (Amaranthus dubius Mart.), crabgrass (Digitaria sanguinalis (L.) Scop.), jungle rice (Echinochloa colonum (L.) Link.), spurge (Euphorbia heterophylla L.), pepperweed (Lepidium virginicum L.), spreading dayflower (Commelina diffusa Burn. f.), niruri (Phyllanthus niruri L.), morning glory (Ipomoea tiliaceae (Willd.) Choisy), sicklepod (Cassia tora L.), woodsorrel (Oxalis intermedia A. Rich.), and purple nutsedge (Cyperus rotundus L.). Paraquat at 0.56 kg ai/ha rate gave good to excellent control of most of the above-mentioned weeds (table 2). Increasing paraquat concentration to 2.24 kg ai/ha rate improved slightly weed control. Second and third applications of paraquat were needed to give sustained weed control until the canopies of taniers started to close in. Crop injuries caused by drift effect of paraquat at 0.56 kg ai/ha rate was minor and the plants recovered rapidly. Injury was somewhat aggravated with increased rate of paraquat application.

The highest tuber yield was obtained when paraquat was applied at 1.12 kg ai/ha followed by 0.56 kg ai/ha. Paraquat at the highest rate of 2.24 kg ai/ha ranked third and weeded check fourth in yield. These yield differences were not statistically significant. The non-weeded check was the one treatment with significantly lower tuber yield.

DISCUSSION

In yams, two postemergence applications of paraquat were made within the first three months after planting. A third postemergence application was planned but not needed because of the lack of sufficient weed infestation in the Corozal plots. However, a minimum of three postemergence applications of paraquat is required for adequate weed control in the coastal area of the Island where weeds grow profusely. As far as the crop safety is concerned, paraquat-affected plants recovered rapidly and the injury was localized to the vines and leaves. Very rarely, paraquat at normal 1X rate caused the death of yam plants.

In taniers, three postemergence applications of paraquat were performed during the first three to four months. Weed competition during this period of time was very severe. As soon as the canopy of taniers began to close in, further paraquat treatment was not considered imperative. The crop injury resulting from paraquat drift was considered to be of minor importance. Paraquat burned or caused necrotic spots when it came into direct contact with leaf tissue and lacked the systemic action of killing the entire tanier plant as in the case of glyphosate injury (3). Consequently, paraquat is a safer postemergence herbicide to use for weed control in taniers.

All above postemergence applications of paraquat for weed control in both crops were made with a knapsack sprayer at a reduced spraying pressure. Consequently, crop injury was kept to a minimum.

Acknowledgements

We thank Chevron Chemical Company for their help in carrying out the paraquat residue determinations. Part of this experimentation was conducted with a grant-in-aid provided by the cited company.

LITERATURE CITED

1) ANONYMOUS (1980). Anuario de Estadísticas Agrícolas de Puerto Rico: Estimados Preliminares del Ingreso Agrícola de Puerto Rico, Departamento de Agricultura del Estado Libre Asociado de Puerto Rico.

2) HERBICIDE HANDBOOK COMMITTEE. (1979). Herbicide Handbook of the Weed Science Society of America 4: 329.

3) LIU, L. C. and A. ACEVEDO-BORRERO. (1978). Chemical weed control in taniers J. Agri. Univ. P.R. 64(4): 442-9.

4) ZWEIG, GUNTER. (1967). Analytical methods for pesticides. Plant growth regulators and food additives, Volume V: 478-81, Academic Press, New York and London.

Table 1.-Effect of different concentrations of paraquat on weed control, phytotoxicity and yield of yams at the Corozal Substation

Herbicide treatment	Weed control at 1/			Phytotoxicity at 2/			Tuber yield (kg/ha) 3/
	20 days	60 days	Ave.	20 days	60 days	Ave.	
1. Paraquat 0.56 kg/ha (twice)	93	89	91	3	2	2	26,679 a 4/
2. " 1.12 " "	93	89	91	4	2	3	28,423 a
3. " 2.24 " "	96	93	95	10	5	8	23,018 a
4. Weeded check	95	95	95	0	0	0	22,726 a
5. Non-weeded check	0	0	0	0	0	0	16,449 b

1/ Weed control ratings are based on a scale of 0-100: 0 = no control, 100 = complete control

2/ Phytotoxicity evaluations are based on a scale of 0-100: 0 = no phytotoxicity, 100 = completely affected

3/ Tuber yield is the average of four replications

4/ Values followed by one or more letters in common do not differ significantly (P = 0.05)

Table 2.-Effect of different concentrations of paraquat on weed control, phytotoxicity and yield of taniers at the Isabela Substation

Herbicide treatment	Weed control at[1]			Phytotoxicity at[2]			Tuber yield (kg/ha)[3]
	8-8-79	9-28-79	Ave.	8-8-79	9-28-79	Ave.	
1. Paraquat 0.56 kg/ha (thrice)	87	84	86	8	8	8	15,385 a[4]
2. " 1.12 " "	93	85	89	13	5	9	16,580 a
3. " 2.24 " "	95	90	93	20	8	14	15,333 a
4. Weeded check	95	90	90	0	0	0	14,927 a
5. Non-weeded check	0	0	0	0	0	0	3,687 b

1/ Weed control rating is based on a scale of 0-100: 0 = no control, 100 = complete control

2/ Phytotoxicity evaluations are based on a scale of 0-100: 0 = no phytotoxicity, 100 = completely affected

3/ Tuber yield is the average of four replications

4/ Values followed by one or more letters in common do not differ significantly (P = 0.05)

Table 3.-Summary of paraquat residue present in mature tubers of yams

Herbicide treatment	Residue (ppm) Found
Paraquat 0.56 kg ai/ha	
Composited sample no. 1	0.00
Composited sample no. 2	0.01
Paraquat 1.12 kg ai/ha	
Composited sample no. 1	0.00
Composited sample no. 2	0.00
Check	
Composited sample no. 1	0.00