cause of the similarity in inputs and intensive management practices used in each. Vegetables are presently being grown adjacent to tobacco on many farms. In the absence of an adequate marketing system however, increased vegetable production may not be economically feasible.

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CHEMICAL CONTROL OF NUTSEDGE (CYPERUS ROTUNDUS L.)[1]

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Abstract. **Two field experiments were conducted in 1973 and 1974 to determine the effectiveness of herbicides in controlling purple nutsedge (Cyperus rotundus L.). Herbicides evaluated were: 1,1'-dimethyl-4,4'-bipyridinium ion (paraquat); 2,4-dichlorophenoxy acetic acid (2,4-D); 1-methyl-4-phenylpyridinium chloride (S21634); 3-isoprophyl-1H-2,1,3-benzothidiazin-(4)3H-one 2,2-dioxide (bentazon); N-(phosphonomethyl)glycine (glyphosate); 2-(a-naphthoxy)-N,N-diethylpropionamide (napropamide); S-ethyl dipropylthicarbamate (eptam); and 4-phenylsulfonyltrifluoro methanesulfono-o-toluidide (MBR-8251). Herbicides were applied 3 times at one month intervals, with the soil remaining fallow until 4 weeks after the last application. Vegetable and flower crops were planted to determine herbicide persistence and toxicity. Glyphosate, napropamide, and MBR-8251 reduced 1973 nutsedge populations by as much as 70% in comparison with untreated areas. Glyphosate, napropamide, and MBR-8251 were effective in reducing nutsedge in 1974, but MBR-8251 was toxic to cucumbers, tomatoes, and peppers. Glyphosate was the most consistently effective herbicide evaluated for reducing nutgrass population and exhibited no phytotoxicity on subsequent crops.**

Purple nutsedge (*Cyperus rotundus* L.), an obnoxious weed in most warm regions of the world, has dormant tubers that make chemical control difficult and eradication nearly impossible (9). Seasonal control has been obtained with several herbicides, but reinfestation usually occurs within a few months (2, 6, 12). The more effective chemicals are persistent in the soil and become phytotoxic to subsequent crops (12). The most effective chemical for short-term control of nutsedge in Florida has been 2,4-D, applied in multiple applications during the summer fallow season (1, 2). The warm moist summers in Florida rapidly reduce the activity of 2,4-D, making the soil safe for fall planting of sensitive plants 30 days after treatment (1). Unfortunately, 2,4-D only reduces the nutsedge population and does not eradicate it.

Within the past 5 years, several new chemicals have shown promise as herbicides on nutgrass. These are: 1-methyl-4-phenylpyridinium chloride (S21634) (4, 7); 3-isoprophyl-1H-2,1,3-benzothidiazin-(4)3H-one, 2,2-dioxide (bentazon) (11); 2-(a-naphthoxy-N,N-diethylpropionamide (napropamide) (3); 4-phenylsulfonyltrifluor methanesulfono-o-toluidide (MBR-8251) (5, 10); and N-(phosphonomethyl) glycine (glyphosate) (8). Preliminary studies indicate these herbicides actively eradicate nutsedge without persistence in the soil.

Objectives of this study were to evaluate selected herbicides in controlling purple nutsedge during the summer fallow season and to determine residual effects on crops planted later in the treated area.

Methods and Materials

Two field experiments, each a randomized complete block design, were conducted on Myakka fine sand (pH 5.8-6.2) heavily infested with purple nutsedge. The area was irrigated by open-seep ditches and was rototilled to a 5 inch depth 6 weeks prior to initial herbicide applications. Postemergent herbicides were applied 2 weeks prior to rototilling on the 3 application dates. Preemergent herbicides were applied just prior to or after rototilling, depending upon their mode of activity. Prior to planting on 30 inch wide by 6 inch high beds, all plots were disked twice and rototilled once. Nutsedge populations were estimated 2 weeks after each rototilling by counting nutsedge plants in 3 randomly selected one square foot areas and calculating the estimated mean number per plot. All liquid treatments were applied at a rate of 80 gpa with a knapsack sprayer using approximately 40 psi of pressure and a single 80° (8002) tee-jet nozzle. Granular herbicides were distributed with a Gandy applicator.

Experiment I was begun on May 3, 1973, when the area was first rototilled. Plot size was 279 square feet and each treatment was replicated 4 times. Postemergent herbicides and lb, aia rates, applied on June 15, July 13 and August 17, were: 1,1'-dimethyl-4,4'-bipyridinium ion (paraquat), 0.5; 2,4-dichlorophenoxy acetic acid (2,4-D), 3.0; 1-methyl-4-phenyl-pyridinium chloride (S21634), 2.0; 3-isoprophyl-H-2,1,3-benzothidiazin-(4)3H-one 2,2-diozide (bentazon), 2.0; *N*-(phosphonomethyl)glycine (glyphosate), 2.0; and a combination of S21634 and glyphosate, 2.0 + 2.0. Preemergent herbicides and lb. aia rates, applied on June 29, July 27, and August 31, immediately prior to rototilling, were: 2-(a-naphthoxy)-N,N-diethylpropionamide (napropamide), 6.0; and *S*-ethyl dipropylthiocarbamate (eptam), 6.0. The preemergent herbicide 4-phenylsulfonyltrifluoromethanesul-

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fono-o-toluidide (MBR-8251) was applied at 4 lb. aia immediately following rototilling on June 29, July 27, and August 31. An unweeded check plot was sprayed with water on all postemergence application dates. Nutsedge counts were made on July 13, August 6, and September 14, 1973. Unmulched raised beds were prepared and 9 tomato (*Lycopersicum esculentum* Mill. 'Walter'), 9 bell pepper (*Capsicum frutescens* L. var. grossum, 'Yolo L'), 18 petunia (*Petunia hybrida* Vilm 'Comet'), and 18 ageratum (*Ageratum houstonianum* Mill. 'Blue Mink') plants were transplanted in each plot on October 1. Cabbage (*Brassica oleracea* L., 'Copenhagen') seed was sown in a single row on raised beds October 2 using a precision garden seeder and plants were thinned to 18 per plot November 1. Due to an early freeze, the experiment was terminated December 15 and the plant number and fresh weight of each crop were measured immediately.

Experiment II was started on March 25, 1974, when the area was rototilled. Plot size was 800 square feet each and each treatment had 3 replications. The postemergent herbicides S21634 and glyphosate were applied at 6 lb. aia on May 10, June 21, and August 2. The liquid formulation of napropamide at 6 and 12 lb. aia and the granular formulation at 6 lb. aia were applied on May 31, July 12, and August 23, immediately prior to rototilling. MBR-8251 at 2 and 4 lb. aia was applied immediately following rototilling. Nutsedge counts were made on June 19, August 6, and September 15. Fertilizer was banded on raised beds and then covered with 1.25 mil black plastic mulch. Holes were punched in the mulch and cucumber (*Cucumis sativus* L., 'Poinsett') and corn (*Zea mays* var. *rugosa* L. cv. Silver Queen) *seed were sown on* September 20 and later thinned to 18 and 40 plants per plot, respectively. 'Walter' tomato and 'Yolo L' pepper transplants were set on Sept. 23 with 28 plants per plot. Forty jumbo (1.5 in. diam.) gladiolus (*Gladiolus grandiflorus* Hort. cv. Friendship) corms were planted in 6 in. wide furrows, covered with soil, and maintained using standard commercial practices. Number and weight of vegetable fruit were recorded at multiple harvest dates when the respective crops were at the commercially acceptable stage of maturity. Gladiolus spikes were cut in the tight bud stage over a ten day period and spike number, length and weight were recorded.

Results and Discussion

Experiment I. The effect of the multiple applications of the various herbicides on nutsedge populations is tabulated in Table 1. The unweeded check treatments had a mean of 72.0, 55.6, and 52.1 nutsedge plants per square foot after 1, 2 and 3 rototillings, respectively. One application of 2,4-D showed a 60% reduction in nutsedge plants, but no significant reduction resulted from 2 or 3 applications (Table 1). Glyphosate, glyphosate + S21634, napropomide, eptam, and MBR-8251 all significantly reduced the nutsedge populations after 1 application. Nutsedge plants sprayed with glyphosate turned yellow within 3-4 days after treatment and were dead before they were rototilled. S21634 caused plants to yellow, while bentazon exhibited no visible effect. Eptam, after the first application, reduced the nutsedge population by almost 85%; additional reductions of 33 and 40% were obtained from the 2nd and 3rd applications, respectively. This response can be explained by the moisture conditions of the soil. At the first application, no appreciable rain had fallen for 3 months and even with seep irrigation, the upper 4-6 in. of soil was dry. The rains started prior to the second application date and the increased soil moisture apparently reduced the mobility and activity of eptam (6). The activity of napropamide apparently was enhanced by the additional soil moisture. Nutsedge reduction for 1, 2, or 3 applications of this chemical were 33, 80, and 70%, respectively, compared to the check plots. Glyphosate, either alone or in combination with S21634, showed a consistent reduction in nutsedge through the 3 applications. MBR-8251 was inconsistent, but did reduce the nutsedge after the first and third applications.

Table 1. Effect of 1, 2, or 3 applications of herbicides on mean nutsedge populations, 1973.

Treatment	Rate (lb aia)	Appl. method	No.[z] of nutsedge plants/ft^2 on: 7/13 (1 appl)	8/16 (2 appl)	9/14 (3 appl)
Control	—	—	72.0a[y]	55.6ab	52.1a
Paraquat (2E)	0.5	Post-E	84.2a	60.8a	35.8abc
2,4-D (4D)	3	"	28.2def	45.5abc	39.1ab
S21634 (3E)	2	"	64.7abc	58.2ab	39.5ab
Bentqzon (80W)	2	"	67.3ab	46.7abc	39.4ab
Glyphosate (3E)	2	"	41.8cde	30.0cde	18.4cd
Glyphosate + S21634	2+2	"	39.1de	24.5de	17.5cd
Napropamide (2E)	6	Pre-E	47.9bcd	11.2e	15.6d
Eptam (6E)	6	"	10.9f	37.3bcd	31.8bcd
MRB-8251 (50W)	4	"	22.3ef	42.8abcd	22.8bcd

[z]Counts made 2 weeks after rotovating fields following preemergent herbicide applications.
[y]Mean separation within columns by Duncan's Multiple Range Test, 5% level.

Yields (fresh weight) of the 5 crops planted on the treated soil are recorded in Table 2. Since the early freeze prevented the crops from maturing, the total fresh weights of the plants are small. Size of pepper plants was reduced by MBR-8251, but was enhanced by S21634, eptam, and napropamide. Napropamide increased pepper yield 3-fold

Table 2. Mean fresh weight of plant biotypes grown on herbicide-treated soil, 1973.

Treatment	(lb aia)	Fresh weight of plant biotypes (lb): Petunia	Ageratum	Pepper	Tomato	Cabbage
Control	—	0.87cd[z]	3.16ab	1.47cd	4.16d	0.77e
Paraquat (2E)	0.5	1.02cd	3.08bc	1.77c	5.22c	1.30cd
2,4-D (4D)	3	1.23bc	2.81bc	1.47cd	6.28b	1.39bcd
S21634 (3E)	2	1.01cd	3.30ab	2.49b	3.40ef	1.67b
Bentazon (80W)	2	0.89cd	2.25d	1.17de	3.2f	1.21d
Glyphosate (3E)	2	0.81d	2.61ed	1.44cd	4.34d	1.52bc
Glyphosate + S21634	2+2	0.84d	2.16d	1.20de	4.32d	1.54bc
Napropamide (2E)	6	5.00a	3.65a	4.92a	10.20a	7.18a
Eptam (6E)	6	1.57b	3.21ab	2.70b	3.84de	1.15d
MBR-8251 (50W)	4	1.15ed	1.38e	0.81e	3.88de	1.67b

[z]Mean separation within columns by Duncan's Multiple Range Test, 5% level.

over the check, primarily by reducing other weed populations in addition to nutsedge. It also increased yield of the remaining crops, especially evident with a 5-fold fresh weight increase in petunia. Yield of cabbage from untreated plots was less due to the competition of weeds which germinated rapidly and grew fast. MBR-8251 exhibited toxicity to ageratum and pepper.

Experiment II. Reduction of nutsedge plant populations during the 1974 trial are recorded in Table 3. After one herbicide application, only the napropamide treatments failed to reduce the nutsedge populations. The rains started very late in the summer of 1974, with very little precipitation prior to August 1. As in 1973, the activity of napropamide was increased in a moist soil, and reduced in a dry soil. Counts made after the second application indicated that only glyphosate and MBR-8251 had significantly reduced the nutsedge population. After three herbicide applications the high rate of napropamide, as well as the other chemicals, greatly reduced the nutsedge. Glyphosate eliminated almost 90% of the nutsedge plants in the plots.

Table 3. Effect of 1, 2, or 3 applications of herbicides on nutsedge populations, 1974.

Treatment	Rate (lb aia)	Appl method	No.[z] nutsedge plants/ft² on: 6/19 (1 appl)	8/6 (2 appl)	9/15 (3 appl)
Control	—	—	62.0a[y]	42.6a	33.1a
S21634 (3E)	6	Post-E	31.9bc	27.5ab	10.4b
Glyphosate (3E)	6	"	14.3c	16.9b	2.8b
MBR-8251 (50W)	2	Pre-E	17.7c	13.0b	12.0b
MBR-8251 (50W)	4	"	19.7c	11.6b	10.6b
Napropamide (2E)	6	"	59.2ab	41.7a	31.6a
Napropamide (2E)	12	"	51.0ab	30.7ab	13.9b
Napropamide (10G)	6	"	40.9abc	44.1a	35.3a

[z]Counts made 3 weeks after rototilling fields following preemergent herbicide applications.
[y]Mean separation within columns by Duncan's Multiple Range Test, 5% level.

Table 4. Total fruit weight of 4 plant biotypes grown on herbicide-treated soil, 1974.

Treatment	Rate (lb aia)	Weight (lb) of fruit harvested: Cucumber	Tomato	Pepper	Corn
Control	—	43.4a[z]	74.3b	16.1c	35.8bc
S21634 (3E)	6	48.1a	97.7a	25.6b	40.0ab
Glyphosate (3E)	6	48.2a	97.6a	25.6b	43.6a
MBR-8251 (50W)	2	0 c	0.4c	4.8d	41.2ab
MBR-8251 (50W)	4	0 c	0.3c	2.2d	35.4bc
Napropamide (2E)	6	17.0b	78.1b	24.9b	27.9c
Napropamide (2E)	12	1.1c	101.6a	38.2a	4.5d
Napropamide (10G)	6	13.6b	87.1ab	26.1b	13.4d

[z]Mean separation within columns by Duncan's Multiple Range Test, 5% level.

Vegetable crop yields in the treated soil are shown in Table 4. MBR-8251, at both rates, and napropamide, either as a liquid or granular formulation, significantly decreased cucumber yields. Cucumber seed in the MBR-8251 plots either failed to germinate or did not grow past the 2-3 leaf stage. This chemical was also phytotoxic to tomato and pepper but showed no effect on corn. Enhancement of tomato yields with S21634, glyphosate, and the 12 lb. rate of napropamide as compared to check plots was due primarily to reduction of weed competition. The low rate of napropamide failed to reduce the weed population and was therefore associated with lower yields. A similar response was indicated with pepper, although the 6 lb. rate of napropamide increased yields as compared to the check.

Corn, the only monocotyledon vegetable in the group, showed the specificity of the various chemicals evaluated. MBR-8251, which was highly phytotoxic to the dicotyledons, showed no effect on corn. Napropamide, which is specific for grasses, reduced corn yields. S21634 and glyphosate again significantly increased corn yields as compared to the check plots.

Number and quality of gladiolus spikes harvested during the 10-day period were affected by chemical treatment (Table 5). MBR-8251, at both the 2 and 4 lb. rates, greatly reduced the number of spikes harvested. The spikes that developed in these treatments were short, light-weight, and chlorotic. Napropamide (2E) at the 6 lb. rate was the only treatment that significantly produced more spikes than the control. The 12 lb. rate of napropamide showed some plant toxicity, which reduced flower yield below the control plots. Corm and flower yields followed similar patterns. MBR-8251 greatly reduced corm yield while the 6 lb. rate of napropamide, either as a liquid or granular formulation, increased corm yield.

Table 5. Flower and corm yield (fresh weight) of gladiolus 'Friendship' grown on herbicide-treated soil, 1974.

Treatment	Rate (lb aia)	Spikes: Number	Length (in.)	Weight (oz)	Corm weight (lb)
Control	—	44.7b[z]	43.8cd	2.7de	8.4cd
S21634 (3E)	6	48.0ab	46.2abc	3.0cd	8.4cd
Glyphosate (3E)	6	52.0ab	47.6a	3.2abc	10.5bc
MBR-8251 (50W)	2	19.3d	42.2d	2.5e	6.2d
MBR-8251 (50W)	4	14.7d	32.5e	1.8f	5.9d
Napropamide (2E)	6	53.0a	46.1abc	3.1bc	11.0b
Napropamide (2E)	12	30.7c	45.1bc	3.3ab	10.7bc
Napropamide (10G)	6	52.7ab	47.1ab	3.5a	13.6a

[z]Mean separation within columns by Duncan's Multiple Range Test, 5% level.

Summary

Results of these tests indicate that nutsedge can be controlled by multiple chemical and fallow treatments during the summer in Florida, with no phytotoxicity to subsequent crops. Napropamide was active only during high soil moisture periods and was phytotoxic to corn and gladiolus at a high application rate. Gladiolus flower and corm yields were significantly improved at the low rate (6 lb. aia) of this chemical. MBR-8251 greatly reduced nutsedge populations but was phytotoxic to gladiolus, cucumber, tomato, and pepper. S21634 and glyphosate both reduced nutsedge without phytotoxicity to subsequent crops, with the latter being the most consistent during 2 years of evaluation.

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EFFECT OF SPACING AND FERTILIZER RATES ON CABBAGE YIELD AND HEAD WEIGHT

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Abstract. **The cabbage hybrid, 'Rio Verde', was grown at spacings of 9, 12, and 15 inches in rows on 30-inch centers and in 3-row beds on 60-inch centers, under 3 levels of fertilization at Sanford. Yield responses, average weight of heads, and per cent marketable cabbage data were taken on 3 plantings to represent fall, winter, and spring crops. First harvest dates were February 19, April 1, and May 5, 1976.**

Soil samples were taken before and after the growing season. *Highest marketable* yields for all three plantings were obtained on the 30-inch rows with plants spaced 12 inches and the high fertilizer rate. The average head weight was 3.8 pounds for this treatment. The lowest marketable yield was with 3 row beds at 9-inch spacing and the low fertilizer rate.

A rapid increase in cabbage production costs with little increase in price per crate has emphasized the importance of good cultural practices to reduce costs. Traditionally, growers have increased production per acre to off-set the increased cost of production. Higher yields per acre have been achieved by higher rates of fertilizer, closer spacings, new cultivars, better pest control, and attention to water management.

It has long been accepted that applications of nitrogen fertilizer to cabbage increased yields, plant uniformity, and quality (2, 4). Plant spacing has also been shown to be related to head weight and per cent marketable yield (1, 3). In general, as the plant spacing is increased the head weight increased and the per cent marketable cabbage increased. Hybrid cultivars have also produced higher yields of marketable cabbage than the open-pollinated types (1, 5).

The objective of this study was to determine the response of a widely grown cabbage hybrid to three plant spacings in the row with two row spacings and three rates of fertilizer on the yield, size of head, and percent marketable heads.

Methods

Soil samples were taken before and after the growing season to determine the fertility level of the Leon fine sand.

The hybrid cultivar, 'Rio Verde', was transplanted in October and December 1975, and in February 1976, to represent the fall, winter, and spring growing seasons in central Florida. Plant populations varied from 13,939 to 34,848 plants per acre by in-row spacings of 9, 12, and 15 inches on row widths of 30 inches, and three 20 inch rows giving 3 rows per five feet (Table 1).

Table 1. Calculated plant populations for treatments in a spacing and fertilizer rate study.

Treatment	Plants/acre
30″ Rows	
9″	23,232
12″	17,424
15″	13,939
3 Rows/5′	
9″	34,848
12″	26,136
15″	20,909

Three rates of nitrogen fertilizer were applied to each of the plant and row spacings, for a total of eighteen treatments. The applications of fertilizer were split into three increments for 125 and 200 pounds nitrogen (N) per acre (A). The 275 pounds N/A treatment was split into four increments. All of the nitrogen for the 125 and 200 pound treatments came from mixed sources (5-5-8-2 and 10-4-10-3 commercial fertilizer). The 275 pound treatments received 200 pounds from the mixed goods plus 75 pounds per acre from ammonium nitrate. The first application was made after transplanting. Subsequent applications were made at approximately two week intervals. All applications were hand applied and lightly incorporated with hand equipment.

A randomized complete block design was used with six replications. Plots were 5 or 10 feet wide by 15 feet long, containing three, 20-inch rows (3 rows per 5 feet) or four, 30-inch rows.

Yield data was taken by counting, grading, and weighing each plot when the majority of cabbage was ready. Each plot was harvested twice.

Results and Discussion

Soil analyses at the end of the growing season indicated minimal residual nitrogen fertilizer, but high residual phosphorus and adequate levels of potassium, calcium, and magnesium. The higher plant population plots appeared to have a lighter green color and smaller head size than did the 30″ row with 200 or 275 pounds N/A plots.

The average cabbage head weight increased with row width, the in-row spacing, and generally as the amount of nitrogen per acre increased (Table 2). The 30-inch rows with 15-inch in-row spacing and 275 pounds N/A produced the heaviest heads with an average weight of 4.2 pounds. The three, 20-inch rows with 15-inch in-row spacing and

[1]Florida Agricultural Experiment Stations Journal Series No. 279.