

SOME FACTORS AFFECTING THE CONTROL OF
YELLOW NUTSEDGE (cyperus esculentus)

by

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LITERATURE REVIEW

Yellow nutsedge (Cyperus esculentus) is one of the worst weed pests in agricultural crops. The United States Department of Agriculture considers it to be among the top five worst weeds (29). It is particularly a problem in agronomic crops such as cotton, soybeans and rice. Because of the economic importance of these crops, considerable research has been done to determine better methods of control. With the advent of minimum tillage practices, including decreased deep plowing and mechanical cultivation, nutsedge has become more prevalent.

Horticulturists do not always have the options of cultivation or crop rotation that are utilized for growing agronomic crops. This is particularly true of homeowners and turfgrass managers who, except during periods of establishment or renovation cannot take advantage of these methods (28). Consequently, other methods of control must be considered.

Several interrelated factors affect control of yellow nutsedge. Perhaps the most important of these are its high reproductive potential and the varying degrees of dormancy of tubers that are produced.

In many cases, better control could probably be achieved if more individuals were aware of the stages in the life cycle of the plant and in which of these stages it was most susceptible to control (14,15,16,21, 22,25,26,27,31).

Plant Description

The above ground portion of the plant consists of a triangular fascicle of yellowish green leaves developing from a basal corm. Leaf development is sequential from the outside toward the center of the corm. Growth terminates with the development of a seed bearing raceme, which extends through the center of the fascicle (31).

The below ground portion of the plant consists of the basal corm, from which extend fibrous roots and rhizomes. During the growing season, the rhizomes are capable of forming more rhizomes, basal bulbs, or tubers.

Yellow nutsedge is capable of producing new growth from seed, the basal bulb, nodes on the rhizomes and from tubers on the rhizomes (26,27). The primary reproduction method is considered to be from tubers (24,27). Tumbleson and Kommedahl (27) published data that illustrated the potential of yellow nutsedge to spread. In June 1959, they planted one tuber and by July 1960, the tuber had produced 1918 individual plants and 6864 tubers. They estimated total tuber production under optimum conditions in peat to be eight tons per acre.

Tuber production occurs throughout the top 50 centimeters of the soil surface (21,24) with the majority produced in the surface 15 to 20 centimeters. Tuberization occurs primarily from early July until mid October and is dependent on photoperiod (15). Optimum photoperiod for tuber formation is 8 to 12 hours (14) with the greatest number being formed during the shorter photoperiod of September and October.

Each tuber is capable of germinating more than once (21) and while germination is not dependent on size, there is an indication that it

influences subsequent plant vigor. Tuber germination is often delayed for long periods of time. Stoller and Wax (22) found, under optimum conditions, tubers could remain dormant for up to 22 months. The author has successfully germinated tubers that have been stored for 27 months. Since all tubers are not in the same dormancy stage at a given point in time, germination can occur over an extended period of time with shoots appearing from mid to late April until August (22).

The second most important method of reproduction is by seed. Large quantities of viable seed are produced (9,14,26). Hill et al (9) calculated potential seed production at approximately 45,000 grams per acre, capable of producing between 11 and 125 million plants per acre. Jansen (14) reported that seed formation required a photoperiod of 12 to 14 hours and that 50% to 90% of the seed produced could germinate.

Control Methods

Mechanical cultivation

In the past, the recommended method of control for agronomic and horticultural crops has been deep and frequent hoeing and, in extreme cases, the use of hogs to grub out the plants (8). Mechanical cultivation is indeed a good method of control in agronomic and horticultural crops that can be cultivated. Mechanical cultivation stimulates the breaking of tuber dormancy, which once they have sprouted are more susceptible to chemical control (25). Stoller and Wax (22) observed that tubers exposed to winter temperatures below -7°C exhibited only 50% survival if they were located in the top 5 centimeters of soil.

Chemical control

Chemical control with herbicides is presently the most efficient and effective method of controlling yellow nutsedge. It is, however, a long term method requiring two to three years of treatment.

In order to be most effective, herbicides must be applied at the appropriate time. With most plants, by late spring or early summer enough vegetative growth has been produced to support the plant through photosynthesis. This active growth results in depletion of the plants carbohydrate reserves which makes it difficult for the plant to recover from any stress to which it may be subjected. However, with yellow nutsedge, carbohydrate reserves are not substantially reduced after the first growth in the spring. The low point in carbohydrate reserves occurs in late summer when active growth has stopped (25).

With most herbicides, timing applications for yellow nutsedge to the 3 to 5 leaf stage and very active growth, enhances the herbicidal activity and its effectiveness. Adequate moisture also aids control (3,4,6,19,28). According to Ashton and Craft (1), herbicide uptake will be further enhanced if the humidity around the plant is high. They contend that if the water content of the cuticle is high, any spray droplet that comes in contact with the water continuum of the cuticle will have access to the plant almost instantly.

Application rates are particularly important. Excessive rates could possibly preclude any translocation of the herbicide because of phytotoxicity. In turfgrass, excessive rates of perfluidone have been shown to cause slight foliar burn to Kentucky bluegrass (4) as well as root retardation (19). Bentazon also showed slight foliar burn to Kentucky

bluegrass; however, it was temporary in nature (12,18). Cyperquat exhibited no injury to turfgrass when applied at 2 pounds per acre (13). Conversely, insufficient application rates provide inadequate control. There is also some indication that sublethal rates cause greater infestation through tuber stimulation (2,30).

Control results have varied depending on the herbicide used and the rate of application. Dunn et al (6) obtained acceptable control with 2,4-D, 2,4-D plus dicamba, MSMA, MSMA plus 2,4-D and 2,4-D plus MCPP plus dicamba, all which reduced nutsedge shoots to one-third that of control plots. Excellent control was obtained in Kentucky bluegrass with split applications of bentazon applied at a rate of one plus one pounds per acre, applied 10 to 14 days apart, with tolerance rates of four pounds per acre without injury to the turf (18). Kern et al (19) observed that bentazon, cyperquat and perfluidone gave excellent control but that perfluidone did exhibit some retardant properties. Stoller et al (23) noted similar detrimental responses on soybeans. Tweedy et al (28) observed that for single applications, cyperquat provided the best control but that bentazon, MSMA, MSMA plus 2,4-D gave excellent results with split applications. Bingham (3) reported that cyperquat, perfluidone, and bentazon gave excellent control of yellow nutsedge but that bentazon required split applications for control that was equivalent to perfluidone and cyperquat. Black and Turgeon (4) obtained excellent results with repeated applications of bentazon and cyperquat. Schwartzbeck (20) reported that in green house studies, excellent control of yellow nutsedge was obtained when it was in the 6 to 9 leaf stage with 3 to 6 pounds per acre of cyperquat.

Other control methods

Cultural practices can reduce both tuber and rhizome development. Black and Turgeon (4) found that as mowing height and fertility rates increased, nutsedge density decreased. Tweedy et al (28) observed that while mowing and competition from Kentucky bluegrass reduced rhizome growth and weekly mowing prevented tuber development, nutsedge adapted well. Keeley and Thullen (16) found that in several agronomic and horticultural crops, that shoot and tuber production was directly related to the amount of light received. With 50% shade, flower production was essentially absent. Frick et al (8) and Keeley et al (17) found that if infestation by Bactra verutana was heavy enough and early enough, control on a limited basis was possible. However, if these conditions were not met, slightly injured plants could survive to produce numerous shoots and tubers.

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MANUSCRIPT

This manuscript is written in the style of and
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The Control of Yellow Nutsedge (Cyperus esculentus) With Selected
Chemicals¹

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Abstract. The effectiveness of three herbicides, bentazon (3-isopropyl-1H-2,1,3-benzothiadiazin-(4) 3H-one 2, 2-dioxide), cyperquat (1 methyl-4-phenylpyridinium) and prefluidone (1,1,1-trifluoro-N-(2-methyl-4-(phenylsulfonyl) phenyl) methanesulfonamide) was evaluated for the control of yellow nutsedge (Cyperus esculentus). The two chemicals applied the first year reduced plant populations when compared to the controls except for one date, however there were no significant differences in effectiveness of control between chemicals. In the second years' study all split applications of the three herbicides resulted in significant reduction of plant counts 8 weeks after treatment.

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Yellow nutsedge (Cyperus esculentus) is a serious weed for many crops and turfgrasses throughout the United States. With the decrease in mechanical cultivation it has become more prevalent. However, most homeowners and turfgrass managers do not have the option of mechanical cultivation except during establishment. Kern et al (5) reported control of yellow nutsedge with single and split applications of bentazon, cyperquat, and perfluidone. Johnson (4) reported control of purple nutsedge in warm season turfgrass with bentazon and perfluidone. Tweedy et al (6) found that split applications of bentazon, cyperquat, MAMA, and MAMA plus 2,4-D gave excellent control of yellow nutsedge. They also noted that for single applications cyperquat was the most effective. The best control of yellow nutsedge has been reported when plants were in the 3 to 5 leaf stage and not under drought stress (2,3,6).

The objective of this study was to determine the effectiveness of bentazon, cyperquat, and perfluidone on yellow nutsedge.

In August 1978, a study was established on 1.8 by 0.6 m plots, located on the USDA Plant Materials Center near Manhattan, KS. Using a completely random design, bentazon was applied at 2.2 and 4.5 kg per ha and cyperquat at 1.1 and 3.4 kg per ha. Three applications of each treatment were applied on two sites. The soil type on both sites was a Hayney very fine sandy loam. The plots were located in a fallow area and in a planting of sideoats gramma (Boutrioua curtispindula). Both sites were heavily infested with yellow nutsedge.

Each treatment was evaluated using a visual rating of 0 to 10: 0 = 0% killed and 10 = 100% killed. Data was taken 5, 13, 20, 26, and 35 days after treatment (Table 1).

In October 1978, tubers were collected from each of the treated plots, placed in plastic bags and stored in an air and light tight container at 40 F. In February 1979, 5 tubers from each of the plots were planted in 6 by 6 cm plastic pots in the greenhouse. Within three weeks all tubers from the treated plots had germinated. The control plot tubers did not germinate, even after more time. It is possible that the chemical treatment served as an agent to break dormancy of the tubers collected from the treated plots. Bendixen (1) observed that perfluidone had a cytokinin effect on purple nutsedge and Weidman and Appleby (7) indicated that sub-lethal concentrations of some herbicides stimulate plant growth.

In June of 1979, the first field study was repeated on the fallow site with split applications of the original herbicides and perfluidone. Plant counts were taken from random 150 by 150 cm areas in each plot. Counts were taken prior to treatment, 14 days after the initial and prior to the second part of the split application, and six weeks after the second application (Table 2).

In the 1978 field studies, both bentazone and cyperquat were effective in controlling yellow nutsedge (Table 1). At low rates on the fallow site, cyperquat was not as effective as bentazon at all sampling dates. Also at the higher rates there were significantly fewer nutsedge plants killed at the first sampling date in the plots receiving cyperquat. With a single exception, there were no significant differences in the control of nutsedge between the two herbicides in the plots on the sideoats gramma site. Further the observed nutsedge control was consistently higher on the sideoats gramma plots than on those on the fallow ground. It appears that if a competing crop is present, the nutsedge is more easily suppressed.

This was documented by Tweedy et al (6) with Kentucky bluegrass, who indicated that proper mowing heights and fertilizer rates enhanced the ability of the turfgrass to compete, resulting in lower nutsedge populations.

Fourteen days after the initial treatments in June 1979 there were no significant differences in number of nutsedge plants present on the treated plots. After eight weeks there were significant differences in all plots receiving split applications of the three herbicides, and one additional rate each of cyperquat and perfluidone. Split applications have been reported as providing better control than single applications in some cases (6). One reason for this is that the second application of the chemical controls plants that have germinated after the first treatment, resulting in better control.

Tubers were collected from the 1979 field treated plots and planted in 6 x 6 cm plastic pots in the greenhouse. Data collected included germination percentage, plant height and dry weight. There were no significant differences observed for any of these factors between treatments including controls. It is possible that the tubers were not affected by the treatments because the chemicals were not translocated to them.

Table 1. Yellow nutsedge response to post emergence application of bentazon and cyperquat on fallow ground and in sideoats gramma (1978)

Area and Chemical	Rate kg/ha	Yellow Nutsedge Control % Killed				
		Days After Treatment				
		5	13	20	26	35
<u>Fallow</u>						
Control	0	7	10	7	15	18
Bentazon	2.2	45	63	65	70	70
	4.5	43	58	67	67	67
Cyperquat	1.1	20	35	51	53	53
	3.4	26	52	65	70	67
----- LSD (.05) =		15	19	16	16	17
<u>Sideoats gramma</u>						
Control	0	10	10	16	18	22
Bentazon	2.2	82	82	88	87	87
	4.5	63	78	80	83	82
Cyperquat	1.1	68	88	88	88	87
	3.4	43	75	82	82	83
----- LSD (.05) =		22	19	13	10	11

Table 2. Plant count reduction of yellow nutsedge in response to post emergent application of bentazon, cyperquat and perfluidone (1979).

Chemical	Rate kg/ha	Plant Count Days After Treatment		
		0	14	56
		Plant Count	Plant Count	Plant Count
Control	0	73	22	10
Bentazon	2.2	48	19	3
	4.5	60	20	6
	2.2 + 2.2	57	25	0
Cyperquat	1.1	63	46	1
	3.4	37	34	5
	1.7 + 1.7	71	35	0
Perfluidone	4.5	51	38	3
	9.0	51	31	0
	4.5 + 4.5	61	35	0
LSD (.05) =		43	31	8

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The effectiveness of three herbicides, bentazon (3-iso-propyl-1H-2, 1,3-benzothiadiazin-(4) 3H-one 2,2-dioxide), cyperquat (1 methyl-4-phenyl-pyridinium) and perfluidone (1,1,1-trifluoro-N-(2-methyl-4-(phenylsulfonyl) phenyl) methanesulfonamide) was evaluated for the control of yellow nutsedge (Cyperus esculentus). All chemicals regardless of rate or year significantly reduced nutsedge populations when compared to untreated controls. Cyperquat at the low rate killed significantly fewer nutsedge plants than did bentazon at both rates in the first year studies conducted on fallow ground. Split applications of all three herbicides were effective in reducing plant populations in the second year trials.