Yellow Nutsedge (*Cyperus esculentus*) Interface in Peanut (*Arachis hypogaea*)

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ABSTRACT

Studies were conducted from 1997 to 1999 at the Coastal Plain Experiment Station in Tifton, GA to measure the full-season interference of yellow nutsedge in peanut using a response prediction experiment with a natural infestation of yellow nutsedge. Seeds of cultivar Georgia Green were planted in May each year, and plots were established immediately after crop emergence. Plots were 1.8 m by 1.8 m. with six replications. Yellow nutsedge plants were counted 28 d after crop emergence in each plot, and six weed-free plots were randomly established. Parameters measured were peanut yield and yellow nutsedge tuber contamination in harvested peanut. Yellow nutsedge densities ranged from 0 to 169 plants/m^2. Regression analysis indicated a 25% reduction in peanut yield with a yellow nutsedge infestation of approximately 68 plants/m^2. Each yellow nutsedge plant/m^2 reduced peanut yield by 13 kg/ha. There was a positive linear response between yellow nutsedge density and number of tubers contaminating harvested peanut. Tuber contamination increased by 5190 tubers/ha for every yellow nutsedge plant/m^2. The results indicated that yellow nutsedge is a poor competitor with peanut. However, tuber contamination in harvested peanuts should be considered when using these results in developing treatment thresholds.

Key words: Economic threshold, integrated weed management, response prediction experiment, weed competition.

Yellow nutsedge (*Cyperus esculentus* L.) is one of the most troublesome weeds of peanut (*Arachis hypogaea* L.) throughout the entire peanut producing region in the U.S. (Webster, 2001). Yellow nutsedge reduces crop yields by competition and allelopathy (Keeley and Thullen, 1975, 1978, 1983; Stoller *et al.*, 1979; Drost and Doll, 1980; Patterson *et al.* 1980; Keeley, 1987; Lapham, 1987). Yellow nutsedge tubers can also contaminate shelled peanut by passing through cleaning and blanching processes (Davidson *et al.*, 1982). However, there has been no research to quantify these effects.

Yellow nutsedge is difficult to control due to its perennial growth habit. Tubers are the primary means of propagation (Smith and Fick, 1937; Stoller *et al.*, 1972; Stoller and Wax, 1973; Thullen and Keeley, 1975; Banks, 1983). Yellow nutsedge seed remain viable for many years, but are highly susceptible to drought and desiccation which lessens their role in the spread of the weed (Horak and Holt, 1986; Horak *et al.*, 1987; Lapham and Drennan, 1990). Successful yellow nutsedge control programs must target tubers.

Yellow nutsedge management in peanut is dependent on an integrated system of herbicides, mechanical, cultural, and biological control tactics (Hauser *et al.*, 1966; Thurston, 1976; Linscott *et al.*, 1978; Keeley and Thullen, 1983; Glaze, 1987; Thullen and Keeley, 1987; Grichar *et al.*, 1992; Richburg *et al.*, 1993, 1994; Grichar and Nester, 1997). Effective herbicides reduce tuber production and viability (Banks, 1983). However, control with herbicides is often variable due to tuber depth, dormancy, and environmental factors that directly affect herbicide efficacy (Hauser *et al.*, 1966; Thomas, 1969; Stoller *et al.*, 1972; Stoller and Wax, 1973; Thullen and Keeley, 1975; Stoller *et al.*, 1979).

Most agronomic crops are effective competitors with yellow nutsedge. Cotton (*Gossypium hirsutum* L.) and corn (*Zea mays* L.) suppress growth of yellow nutsedge by shading (Keeley and Thullen, 1978; Stoller *et al.*, 1979). The competitive advantage of crops can be enhanced by manipulating cultural practices such as row pattern, plant population, and planting date that exploit the susceptibility of yellow nutsedge to shading (Ghafar and Watson, 1983; Keeley and Thullen, 1983; Thullen and Keeley, 1987; Johnson and Mullinix, 1999).

Crop rotation can be an effective cultural practice as part of an overall yellow nutsedge management system, especially when crops having effective herbicide options are part of the rotation (Hauser *et al.*, 1974; Thurston, 1976; Lapham, 1987; Menges, 1987; Johnson and Mullinix, 1997). Hauser *et al.* (1974) showed that with intensive weed management in a 3 yr cotton-corn-peanut rotation, numbers of yellow nutsedge tubers were reduced by 97 to 99%. Even moderate weed control systems reduced numbers of yellow nutsedge tubers 78 to 99%. In contrast, lack of crop competition in summer fallow resulted in large proliferation of yellow nutsedge in spite of intensive fallow weed control efforts (Johnson and Mullinix, 1997). Regardless of the crop rotation sequence, a sustained and uninterrupted effort must be placed on depleting yellow nutsedge tubers for many years before benefits of reduced yellow nutsedge populations can be recognized (Glaze *et al.*, 1984; Stoller *et al.*, 1972; Johnson and Mullinix, 1997).

There are several effective herbicide systems to control yellow nutsedge in peanut (Hauser *et al.*, 1966; Grichar *et al.*, 1992, 2000, 2001; Richburg *et al.*, 1993, 1994; Grichar and Nester, 1997; Grey *et al.*, 2001). These options include alachlor [2-chloro-*N*-(2,6-diethylphenyl)-*N*-(methoxymethyl)acetamide], diclosulam [*N*-(2,6-dichlorophenyl)-5-ethoxy-7-fluoro(1,2,4)triazolo(1,5-c)pyrimidine-2-sulfonamide], dimethenamid {2-chloro-*N*-[(1-methyl-2-methoxy)ethyl]-*N*-(2,4-dimethyl-thien-3-yl)-acetamide}, imazethapyr {2-[4,5-dihydro-4-methyl-4-(1-

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methylethyl)-5-oxo-1H-imidazol-2-yl]-5-ethyl-3-pyridinecarboxylic acid}, metolachlor [2-chloro-N-(2-ethyl-6-methylphenyl)-N-(2-methoxy-1-methylethyl)acetamide], and vernolate (S-propyl dipropylcarbamothioate) applied PPI or PRE; bentazon [3-(1-methylethyl)-(1H)-2,1,3-benzothiadiazin-4(3H)-one 2,2-dioxide], and imazapic {(±)-2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazol-2-yl]-5-methyl-3-pyridinecarboxylic acid} applied post emergence (POST). Even if yellow nutsedge is successfully controlled with herbicides, the cost is substantial in peanut. Imazapic, a highly efficacious treatment, costs $43/ha. With current trends in peanut production economics, growers are reevaluating herbicide use patterns in order to improve production efficiency and profitability.

With the significant expenditures for yellow nutsedge control, there is a need to measure interference of yellow nutsedge in peanut and estimate the damage threshold, not only from simple yield reduction but also tuber contamination in harvested peanut. Therefore, studies were initiated to measure interference of yellow nutsedge in irrigated peanut production.

Materials and Methods

Irrigated field experiments were conducted from 1997 to 1999 at the Ponder Farm, a unit of the Univ. of Georgia Coastal Plain Exp. Sta., near Tifton, GA. Soil was a Tifton loamy sand (thermic Plinthic Kandiudults) having 88% sand, 10% silt, 2% clay, and 0.4% organic matter. This site is typical of the peanut production region in the southeastern U.S. coastal plain.

These experiments were designed similar to a response prediction experiment, as described by Gomez and Gomez (1984). A response prediction experiment is used to identify the functional relationship between crop performance and an environmental factor, in this case a naturally occurring population of yellow nutsedge. Regression is the statistical tool used to identify the functional relationship between crop performance and the environmental factor. The key to successfully using a response prediction experiment is choosing an experimental site with variability in the environmental factor being studied. Patterson *et al.* (1980) and Johnson and Mullinix (1999) used similar experimental designs to measure the interference of yellow nutsedge in cotton and cucumber (*Cucumis sativus* L.), respectively.

The experimental site chosen had a heavy natural infestation of yellow nutsedge, with population densities varying from 0 to 169 plants/m^2. There were a total of 48, 72, and 52 plots in 1997, 1998, and 1999, respectively. Each year, six plots were randomly selected as controls and kept weed free throughout the experiment. Exact location of trials within the field was moved among years to prevent confounding effects due to continuous plantings of peanut.

All plots were turned (23 cm deep) with a moldboard plow 1 wk before planting and tilled 7.6 cm deep with a power-tiller to incorporate ethalfluralin [N-ethyl-N-(2-methyl-2-propenyl)-2,6-dinitro-4-(trifluoromethyl) benzenamine] (0.8 kg ai/ha) and shape seedbeds. Seeds of cultivar Georgia Green were planted in early May each year. Annual grasses and dicot weeds not controlled by ethalfluralin were removed by hand weeding. Excluding weed control, pest management and cultural practices for peanut production were based on recommendations from the Georgia Cooperative Extension Service.

Yellow nutsedge plants were counted in each plot approximately 28 d after peanut emergence. Peanuts were dug and inverted with conventional equipment (Kelley Manufacturing Co., Tifton, GA). After air-curing for 7 d, peanut were threshed with a stationary thresher (Kincaid Equipment Manufacturing, Haven, KS). A commercial full-size peanut combine was not used in this trial due to the small plot size and need to thoroughly clean the harvesting equipment between harvest samples to insure accurate measurement of yellow nutsedge tuber contamination. Farmer stock peanut in yield samples were separated by hand from all foreign material contaminants. Concurrently, intact yellow nutsedge tubers were removed from the yield sample. This data was expressed as numbers of tubers contaminating harvested peanut. These data were regressed to determine the effect of yellow nutsedge density on peanut yield and numbers of tubers contaminating harvested peanut. The regression analysis was based on the principles outlined by Draper and Smith (1981) using:

$$Y = a + bx \qquad \text{[Eq. 1]}$$

where Y = parameter being measured, a = intercept, b = slope, and $x = X - \overline{X}$ or midpoint of the yellow nutsedge densities present in the trial.

Results and Discussion

Statistical analysis showed nonsignificant treatment by year interactions among all the possible data combinations (data not shown). Therefore, all data are pooled across years.

Peanut yield. Yield data pooled across 3 yr indicated a quadratic response of peanut yield to yellow nutsedge densities (Fig. 1). Yellow nutsedge reduced peanut yields at densities < 80 plants/m^2; however, as yellow nutsedge densities increased above 80 plants/m^2, peanut yields began to

Figure 1

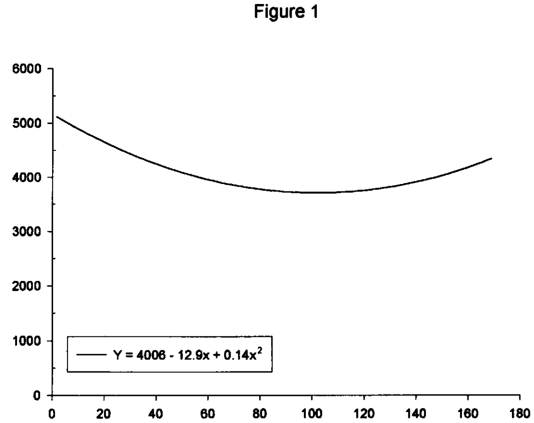

Fig. 1. Effect of yellow nutsedge interference on peanut yield in Tifton, GA; 1997 to 1999. The equation is defined as $Y = a + bx$; Y = 66parameter being measured, a = intercept, b = slope, and $x = X - \overline{X}$ or mid-point of the yellow nutsedge densities present in the trial.

increase. At the maximum densities found in our trial, peanut yields were nearly those in the weed free plots. This is due to intraspecific competition among yellow nutsedge plants in plots with the greatest yellow nutsedge densities. This phenomenon was initially seen by Williams (1981) in greenhouse trials and in yellow nutsedge interference in cucumber (Johnson and Mullinix, 1999).

Based on the predicted peanut yield response to yellow nutsedge, 68 plants/m^2 would reduce peanut yield by 25% compared to the weed free control. In contrast, other species have been shown to be much more competitive with peanut. York and Coble (1977) found fall panicum [*Panicum dichotomiflorum* (L.) Michx.] at 0.1 plants/m^2 reduced peanut yield by 25%, while broadleaf signalgrass [*Brachiaria platyphylla* (Griseb.) Nash] at 1.4 plants/m^2 reduced yields by 25% (Chamblee *et al.*, 1982). Similarly, low densities of the dicot weeds common cocklebur (*Xanthium strumarium* L.) (0.3 plants/m^2), wild poinsettia (*Euphorbia heterophylla* L.) (1.0 plants/m^2), bristly starbur (*Acanthospermum hispidum* DC.) (2.3 plants/m^2), Florida beggarweed [*Desmodium tortuosum* (Sw.) DC] (6.2 plants/m^2), and sicklepod [*Senna obtusifolia* (L.) Irwin and Barneby] (7.2 plants/m^2) were needed to reduce peanut yields by 25% (Hauser *et al.*, 1982; Walker *et al.*, 1989; Bridges *et al.*, 1992; Royal *et al.*, 1997). Clearly, of the weed species commonly found in peanut, yellow nutsedge is among the least competitive.

Tubers in harvested peanut. Numbers of yellow nutsedge tubers increased linearly with increasing yellow nutsedge densities (Fig. 2). For every unit increase in yellow nutsedge density (no./m^2), there was an increase of 5190 tubers/ha in harvested peanut. Furthermore, yellow nutsedge tubers were present in harvested peanut from the weed free plots. These tubers were likely dormant and did not produce a plant because of constant handweeding in weed free plots, although they still contaminated harvested peanut. This shows that yellow nutsedge infestations, including sub-threshold densities that do not affect yield, produce large numbers of tubers that can contaminate harvested peanut.

An interesting relationship was noted between tuber contamination and peanut yield (Fig. 3). As the number of tuber contaminants increased, peanut yields decreased linearly. In contrast, peanut yield response to yellow nutsedge density was a quadratic response, with yields at high yellow nutsedge densities nearly approaching those in the weed free controls (Fig. 1). Undoubtedly, more tubers in harvested peanut are due primarily to increasing yellow nutsedge densities (Fig. 2). The unique growth, production practices, and marketing of peanut greatly complicates the relationship between yellow nutsedge and peanut. The relationship between yellow nutsedge density and peanut yield is affected by intraspecific competition (Fig. 1). However, despite diminishing effects on peanut yield at high densities, these weeds still produce tubers capable of contaminating harvested peanut; hence, the direct negative relationship between peanut yield and tuber contamination.

Peanut growers in the region routinely apply herbicides specifically for yellow nutsedge control. When treatment decisions are based strictly on preventing yield loss from yellow nutsedge alone, our data indicates there would have to be high densities to warrant control. For example, imazapic is the most effective herbicide for yellow nutsedge control (Richburg, 1994) and is commonly applied POST in Georgia. Based on 2003 retail prices, controlling yellow nutsedge with imazapic costs approximately \$55/ha, including application costs (Smith *et al.*, 2003). Peanut sold under contract for edible uses could be marketed at \$0.55/kg. With these assumptions and the predicted peanut yield response (Fig. 1), there would have to be an anticipated yield reduction of at least 100 kg/ha caused by yellow nutsedge interference before the cost of weed control would be recovered. The yellow nutsedge density necessary to reduce peanut yields by this amount is ≥ 3 plants/m^2. In contrast, peanut sold at the minimum loan value of \$0.39/kg would have to have an anticipated 141 kg/ha yield reduction to justify

Figure 2

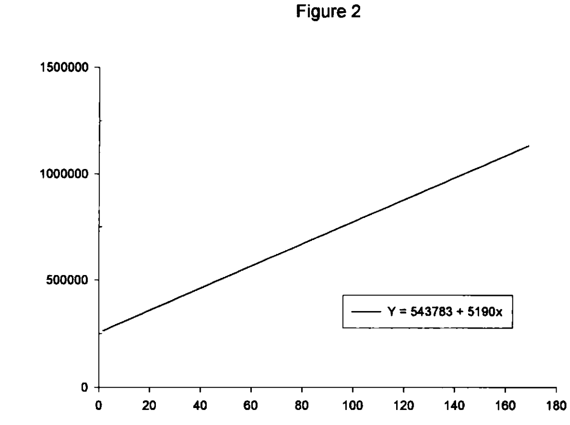

Fig. 2. Effect of yellow nutsedge densities on tuber contamination of farmer stock peanut in Tifton, GA; 1997 to 1999. The equation is defined as $Y = a + bx$; Y = 66parameter being measured, a = intercept, b = slope, and $x = X - \overline{X}$ or mid-point of the yellow nutsedge densities present in the trial.

Figure 3

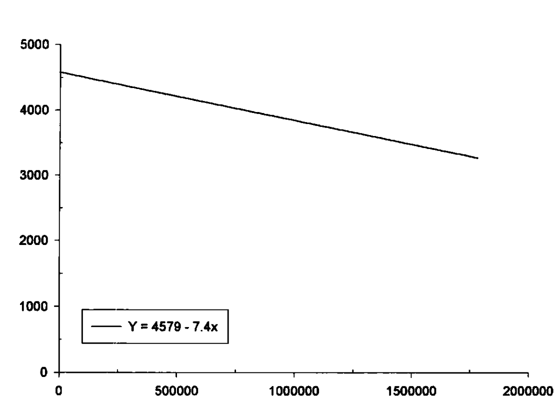

Fig. 3. Effect of yellow nutsedge tuber contamination on peanut yield in Tifton, GA; 1997 to 1999. The equation is defined as $Y = a + bx$; Y = 66parameter being measured, a = intercept, b = slope, and $x = X - \overline{X}$ or mid-point of the yellow nutsedge densities present in the trial.

yellow nutsedge control. The treatment threshold using this scenario would be ≥ 5 plants/m^2. It has been the author's observation that yellow nutsedge is often controlled at densities less than either of these levels, making this treatment a poor managerial decision based on peanut yield reduction alone.

These scenarios are based on preventing yield loss by controlling one weed species (yellow nutsedge), with the most effective option (imazapic). Frequently, other weed species are present that require control decisions, influencing treatment choices. There are other yellow nutsedge control options that are less costly than imazapic and some of these options are applied PRE, thus making field history and speculation on yellow nutsedge infestation necessary for cost effective treatment decisions.

Factors other than yield reduction must be considered in any discussion of yellow nutsedge in peanut. Yellow nutsedge tubers contaminating harvested peanut is a serious issue for the peanut processing industry. Certainly, the majority of yellow nutsedge tuber contaminants come directly from the field with the harvested peanut, with lesser amounts originating from contaminated harvesting equipment. We consistently found yellow nutsedge tubers in yield samples from weed free plots. These tubers were likely dormant and did not produce a plant that interfered with peanut, but nevertheless these tubers contaminated harvested peanut. Any threshold applications of our results need to consider penalties for foreign material contamination or bonuses for no contamination. These quality assessments are controlled by the peanut processing industry and are continually evolving.

In summary, our results clearly show that yellow nutsedge is among the least competitive weeds in peanut, based on yield reduction. However, control decisions based strictly on anticipated yield reduction may result in infestations that have minimal effect on peanut yield but produce tubers that may potentially contaminate harvested peanut. Marketing incentives to compensate growers for the additional inputs and efforts needed to control this troublesome perennial species beyond the benefits of preventing yield loss would help prevent tuber contamination from sub-threshold densities. Otherwise, peanut growers have no compelling reason to control the poorly competitive yellow nutsedge other than to prevent yield reduction. From a peanut grower's perspective, controlling yellow nutsedge at sub-threshold densities without a significant yield response is an unnecessary cost of production.

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Literature Cited

Banks, P.A. 1983. Yellow nutsedge (*Cyperus esculentus*) control, regrowth, and tuber production as affected by herbicides. Weed Sci. 31:419-422.

Bridges, D.C., B.J. Brecke, and J.C. Barbour. 1992. Wild poinsettia (*Euphorbia heterophylla*) interference with peanut (*Arachis hypogaea*). Weed Sci. 40:37-42.

Chamblee, R.W., L. Thompson, Jr., and H.D. Coble. 1982. Interference of broadleaf signalgrass (*Brachiaria platyphylla*) in peanuts (*Arachis hypogaea*). Weed Sci. 30:45-49.

Davidson, J.I., Jr., T.B. Whitaker, and J.W. Dickens. 1982. Grading, cleaning, storage, shelling, and marketing of peanuts in the United States, pp. 571-623. *In* H. E. Pattee and C. T. Young (eds.) Peanut Science and Technology. Amer. Peanut Res. Educ. Soc., Yoakum, TX.

Draper, N.R., and H. Smith. 1981. Applied Regression Analysis. 2nd ed. John Wiley and Sons, New York.

Drost, D.C., and J.D. Doll. 1980. The allelopathic effect of yellow nutsedge (*Cyperus esculentus*) on corn (*Zea mays*) and soybeans (*Glycine max*). Weed Sci. 28:229-233.

Ghafar, Z., and A.K. Watson. 1983. Effect of corn (*Zea mays*) population on the growth of yellow nutsedge (*Cyperus esculentus*). Weed Sci. 31:588-592.

Glaze, N.C. 1987. Cultural and mechanical manipulation of *Cyperus* spp. Weed Technol. 1:82-83.

Glaze, N.C., C.C. Dowler, A.W. Johnson, and D.R. Sumner. 1984. Influence of weed control programs in intensive cropping systems. Weed Sci. 32:762-767.

Gomez, K.A., and A.A. Gomez. 1984. Analysis of data from a series of experiments - response prediction experiment, pp. 355-356. *In* Statistical Procedures for Agricultural Research. 2nd ed. John Wiley and Sons Publ., New York.

Grey, T.L., D.C. Bridges, and E.F. Eastin. 2001. Influence of application rate and timing of diclosulam on weed control in peanut (*Arachis hypogaea* L.). Peanut Sci. 28:13-19.

Grichar, W.J., R.G. Lemon, K.D. Brewer, and B.W. Minton. 2001. S-metolachlor compared with metolachlor on yellow nutsedge (*Cyperus esculentus*) and peanut (*Arachis hypogaea*). Weed Technol. 15:107-111.

Grichar, W.J., R.G. Lemon, D.C. Sestak, and K.D. Brewer. 2000. Comparison of metolachlor and dimethenamid for yellow nutsedge (*Cyperus esculentus* L.) control and peanut (*Arachis hypogaea* L.) injury. Peanut Sci. 27:26-30.

Grichar, W.J., and P.R. Nester. 1997. Nutsedge (*Cyperus* spp.) control in peanut (*Arachis hypogaea*) with AC 263,222 and imazethapyr. Weed Technol. 11:714-719.

Grichar, W.J., P.R. Nester, and A.E. Colburn. 1992. Nutsedge (*Cyperus* spp.) control in peanuts (*Arachis hypogaea*) with imazethapyr. Weed Technol. 6:396-400.

Hauser, E.W., G.A. Buchanan, R.L. Nichols, and R.M. Patterson. 1982. Effects of Florida beggarweed (*Desmodium tortuosum*) and sicklepod (*Cassia obtusifolia*) on peanut (*Arachis hypogaea*) yield. Weed Sci. 30:602-604.

Hauser. E.W., J.L. Butler, J.L. Shepherd, and S.A. Parham. 1966. Response of yellow nutsedge, Florida pusley, and peanuts to thiocarbamate herbicides as affected by method of placement in soil. Weed Res. 6:338-345.

Hauser, E.W., C.C. Dowler, M.D. Jellum, and S.R. Cecil. 1974. Effects of herbicide-crop rotation on nutsedge, annual weeds, and crops. Weed Sci. 22:172-176.

Horak, M.J., and J.S. Holt. 1986. Isozyme variability and breed systems in populations of yellow nutsedge (*Cyperus esculentus*). Weed Sci. 34:538-543.

Horak, M.J., J.S. Holt, and N.C. Ellstrand. 1987. Genetic variation in yellow nutsedge (*Cyperus esculentus*). Weed Sci. 35:506-512.

Johnson, W.C., III, and B.G. Mullinix, Jr. 1999. *Cyperus esculentus* interference in *Cucumis sativus*. Weed Sci. 47:327-331.

Johnson, W.C., III, and B.G. Mullinix, Jr. 1997. Population dynamics of yellow nutsedge (*Cyperus esculentus*) in cropping systems in the southeastern coastal plain. Weed Sci. 45:166-171.

Keeley, P.E. 1987. Interference and interaction of purple and yellow nutsedges (*Cyperus rotundus* and *C. esculentus*) with crops. Weed Technol. 1:74-81.

Keeley, P E., and R J. Thullen. 1983. Influence of yellow nutsedge (*Cyperus esculentus*) free periods on yield of cotton (*Gossypium hirsutum*). Weed Sci. 31:803-807.

Keeley, P.E., and R.J. Thullen. 1978. Light requirements of yellow nutsedge (*Cyperus esculentus*) and light interception by crops. Weed Sci. 26:10-16.

Keeley, P.E., and R.J. Thullen. 1975. Influence of yellow nutsedge competition on furrow-irrigated cotton. Weed Sci. 23:171-175.

Lapham, J. 1987. Population dynamics and competitive effects of *Cyperus esculentus* (yellow nutsedge) - prediction of cost-effective control strategies. Proc. Br. Crop Prot. Conf. 3:1043-1050.

Lapham, J., and D.S.H. Drennan. 1990. The fate of yellow nutsedge (*Cyperus esculentus*) seed and seedlings in soil. Weed Sci. 38:125-128.

Linscott, D.L., R.D. Hagin, and T. Tharawanich. 1978. Control of yellow nutsedge (*Cyperus esculentus*) and other weeds before summer planting of alfalfa (*Medicago sativa*). Weed Sci. 26:399-402.

Menges, R.M. 1987. Weed seed population dynamics during six years of weed management systems in crop rotations on irrigated soil. Weed Sci. 35:328-332.

Patterson, M.G., G.A. Buchanan, J.E. Street, and R.H. Crowley. 1980. Yellow nutsedge (*Cyperus esculentus*) competition with cotton (*Gossypium hirsutum*). Weed Sci. 28:327-329.

Richburg, J.S., III, J.W. Wilcut, and G.R. Wehtje. 1993. Toxicity of foliar and/or soil applied imazethapyr to purple (*Cyperus rotundus*) and yellow (*C. esculentus*) nutsedge. Weed Technol. 7:900-905.

Richburg, J.S., III, J.W. Wilcut, and G.R. Wehtje. 1994. Toxicity of AC 263,222 to purple (*Cyperus rotundus*) and yellow nutsedge (*C. esculentus*). Weed Sci. 42:398-402.

Royal, S. S., B. J. Brecke, and D. L. Colvin. 1997. Common cocklebur (*Xanthium strumarium*) interference with peanut (*Arachis hypogaea*). Weed Sci. 45:38-43.

Smith, N., D. Shurley, W. Givan, and C. Lacy. 2003. Crop enterprise cost analysis - south Georgia 2003. Athens, GA. Georgia Coop. Ext. Ser. Bull. AGECON-94-010-S-Revised. 35 pp.

Smith, E.V., and G.L. Fick. 1937. Nutgrass eradication studies: I. Relation of the life history of nutgrass, *Cyperus rotundus* L., to possible methods of control. J. Amer. Soc. Agron. 29:1007-1013.

Stoller, E.W., D.P. Nema, and V.M. Bhan. 1972. Yellow nutsedge tuber germination and seedling development. Weed Sci. 20:93-97.

Stoller, E.W., and L.M. Wax. 1973. Yellow nutsedge shoot emergence and tuber longevity. Weed Sci. 21:76-81.

Stoller, E.W., L.M. Wax, and F.W. Slife. 1979. Yellow nutsedge (*Cyperus esculentus*) competition and control in corn (*Zea mays*). Weed Sci. 27:32-37.

Thomas, P.E.L. 1969. Effects of desiccation and temperature on survival of *Cyperus esculentus* tubers and *Cynodon dactylon* rhizomes. Weed Res. 9:1-8.

Thullen, R.J., and P.E. Keeley. 1987. Influence of date of planting on the growth of yellow nutsedge (*Cyperus esculentus*). Weed Sci. 35:173-176.

Thullen, R.J., and P.E. Keeley. 1975. Yellow nutsedge sprouting and resprouting potential. Weed Sci. 23:333-337.

Thurston, J.M. 1976. Weeds in cereals in relation to agricultural practices. Ann. Appl. Biol. 83:338-341.

Walker, R.H., L.W. Wells, and J.A. McGuire. 1989. Bristly starbur (*Acanthospermum hispidum*) interference in peanut (*Arachis hypogaea*). Weed Sci. 37:196-200.

Webster, T.M. 2001. Weed survey - southern states; broadleaf crops subsection. Proc. So. Weed Sci. Soc. 54:244-259.

Williams, R.D. 1981. Intraspecific competition of yellow nutsedge. Proc. So. Weed Sci. Soc. 34:231-238.

York, A.C., and H.D. Coble. 1977. Fall panicum interference in peanuts. Weed Sci. 25:43-47.