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PURPLE NUTSEDGE (*CYPERUS ROTUNDUS*) COMPETITION WITH SUGARCANE AND RESPONSE TO SHADE

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ABSTRACT

Purple nutsedge (*Cyperus rotundus* L.) tubers were planted in 26.5 L pots with a surface area of 0.093m^2 at densities of 0, 1, 2, 4, 8, and 16 tubers/pot along with a single node cutting of LCP 85-384 sugarcane (*Saccharum* spp. hybrids) to evaluate weed and crop growth response. At 14, 25, and 38 days after planting (DAP), number of purple nutsedge shoots increased with each incremental increase in tuber density. At 64 DAP, both purple nutsedge shoot and root (including tubers) dry weight increased as initial tuber density increased and root dry weight averaged 3.4 times that of shoot dry weight. At 64 DAP, 37.3 tubers/pot were produced following an initial tuber density of 1/pot compared with 186.3 tubers/pot where the initial tuber density was 16/pot, a 5 fold difference. Based on sugarcane shoot dry weight response to purple nutsedge competition, the critical weed density with LCP 85-384 sugarcane (density of purple nutsedge at which a reduction in shoot weight occurred compared with the weed-free control) was 4 tubers/pot. Based on root dry weight, 1 tuber/pot was the critical weed density. In another pot study, single node cuttings of four sugarcane varieties were planted along with purple nutsedge at densities of 0 and 4 tubers/pot . Averaged across initial tuber densities, sugarcane shoot population at 49 and 64 DAP for L 97-128 averaged 2.5 and 1.7 times more, respectively, than for LCP 85-384, Ho 95-988, and HoCP 96-540. Shoot and root dry weight 64 DAP for L 97-128 averaged 2.0 and 1.7 times that, respectively, of the other three varieties. Averaged across varieties, 4 purple nutsedge tubers/pot reduced shoot dry weight an average of 62% and root dry weight an average of 71%. Field research also evaluated purple nutsedge growth response to varying shade levels. For 30% shade, the lowest shade level, purple nutsedge shoot population was reduced 35, 34, and 53% at 28, 42, and 56 days, respectively, compared with the full sunlight (no shade) control. Purple nutsedge height at 56 days was not negatively affected by 30 or 50% shade, but shoot dry weight was reduced at 30, 50, 70, and 90% shade. Compared with full sunlight, purple nutsedge shoot population at 56 days was reduced at 70 and 90% shade. Purple nutsedge shoot dry weight at 56 days for the 70 and 90% shade treatments was reduced an average of 92% compared with full sunlight. Results show that purple nutsedge at planting can be highly competitive with sugarcane reducing both shoot and root growth. Root development is critical to sugarcane establishment and weed control programs for purple nutsedge should be implemented at planting. Because purple nutsedge growth is greatly reduced by shading, purple nutsedge should not be competitive with established sugarcane.

INTRODUCTION

Sugarcane is a subtropical, perennial crop that is grown within the continental United States only in Florida, Louisiana, and Texas. In Louisiana, four to six harvests are made from a single planting. Over time, disease and weed pressure reduce sugarcane plant density and yield potential such that fields are fallowed and replanted. During the spring and summer fallow period, postemergence application of glyphosate and/or timely tillage operations can be used to control perennial weeds (Anonymous 2009). The fallow period is considered critical for perennial weed management because once sugarcane is planted, row tops are not disturbed for the remainder of the multi-year crop cycle. When herbicides were applied during the fallow period to control johnsongrass [*Sorghum halepense* (L.) Pers.], sugarcane shoot population was greater in the fall after planting and sugar yield was higher at the end of the first growing season (Richard 1997).

Johnsongrass, bermudagrass (*Cynodon dactylon* (L.) Pers.), and purple nutsedge (*Cyperus rotundus* L.) rank 1, 2, and 7, respectively, as the most troublesome weeds in sugarcane in Louisiana (Anonymous 2004). However, in recent years purple nutsedge has become more problematic in Louisiana sugarcane fields. In the 1950's in the Mississippi Delta, when less than 10% of cotton (*Gossypium hirsutum* L.) acreage was treated with herbicides, purple nutsedge was not listed among the top 10 problem weeds (Wills 1977). In 1961, 75% of cotton acreage in the Mississippi Delta was treated with herbicides and by 1963 purple nutsedge ranked as the second most severe weed on sandy soils. The increase in purple nutsedge infestation over the last few years in sugarcane in Louisiana is likely due to the poor control obtained with glyphosate applied during the summer fallow period prior to replanting of sugarcane in August and September (Anonymous 2009). Also contributing to the purple nutsedge problem could be the limited herbicide options available for use in the crop along with the expanded use of the dinitroaniline herbicides, trifluralin and pendimethalin, which are ineffective on purple nutsedge (Dotray et al. 2001; Grichar and Nester 1997; Webster and Coble 1997). When competition from other weeds was reduced with herbicides in Hawaii, a native weed population of 14 nutsedge shoots/m^2 changed to 317 shoots/m^2 in 30 days (Romanowski and Nakagawa 1967). Holm et al. (1997) listed purple nutsedge as the world's worst weed; this status is related to its perennial nature, longevity of viable tubers, and prolific tuber production (Bariuan et al. 1999). Purple nutsedge can produce tubers 21 to 23 days following shoot emergence (Hauser 1962; Smith and Fick 1937). A plant germinating from one tuber produced 64 tubers in 90 days in the greenhouse (Doll and Piedrahita 1982) and 99 tubers under field conditions (Rao 1968).

Competitiveness is the relative ability of a plant to obtain a specific resource when in competition with another plant (Gibson and Liebman 2003). According to Aldrich and Kremer (1997), competition between the weed and crop occurs when some factor, such as water, nutrients, or sunlight, is insufficient to meet the needs of both. In Louisiana, competition from bermudagrass reduced sugarcane and sugar yields 5 to 17% each year of a 3-yr crop cycle (Richard 1993). Bermudagrass biomass in July increased by 340% from the plant cane (first production year) to first ratoon crop (second production year) and 490% between the first and second ratoon (third production year) crops. Full-season johnsongrass competition reduced sugarcane and sugar yields 23 and 17% in the plant cane crop and 42 and 35% in the first ratoon crop, respectively (Millhollon 1995).

Purple nutsedge interference reduced okra (*Hibiscus esculentus* L.) and tomato (*Lycopersicon esculentum* Mill.) yields 62 and 53%, respectively (William and Warren 1975). Leon et al. (2001) reported in greenhouse experiments that initial purple nutsedge tuber densities of more than 180/m^2 reduced fresh weight of cotton and soybean (*Glycine max* L. Merr.). Also, purple nutsedge was found to have superior competitive ability compared to corn (*Zea mays* L.) (Tour and Froud-Williams 2002). Purple nutsedge root, rhizome, tuber, and shoot dry weight increased with increased photoperiod (Williams 1978). Keeley and Thullen (1978) found similar results with yellow nutsedge (*Cyperus esculentus* L.). Even though nutsedge under ideal conditions can have tremendous growth potential, its growth can be affected by shading from the crop. Purple nutsedge shoot population and shoot dry weight were reduced 47 and 67%, respectively, when exposed to 40% shade for 50 days (Santos et al. 1997). Shading significantly reduced dry matter, leaf area, and rhizome and tuber formation of both purple and yellow nutsedge and there was no difference in response to shade between species (Patterson 1982). Field studies have shown that canopy shading from most crops greatly inhibits the growth of both purple and yellow nutsedge contributing to their control (Jordan-Molero and Stoller 1978).

Purple nutsedge tuber sprouting occurs optimally between 25 and 35 C with 80 to 90% sprouting occurring within 10 to 14 days (Aleixo and Valio 1976; Shamsi et al. 1978; Ueki 1969). In Louisiana when sugarcane is planted in August, average soil temperatures are around 30 C and when sugarcane regrowth occurs following the winter dormant period in early March, soil temperatures average around 18 C (Anonymous 2006). It would be expected that purple nutsedge would be especially competitive with sugarcane at plantings in Louisiana. Field studies conducted in Brazil showed that purple nutsedge at 58 to 246 shoots/m^2 reduced sugarcane yield 14% and at shoot populations of 675 to 1198/m^2, sugarcane yield was reduced 45% (Durigan 2005). Studies were conducted in Louisiana to evaluate purple nutsedge competition with sugarcane at planting and purple nutsedge response to shade.

MATERIAL AND METHODS

Competition Studies.

Research was conducted in August 2005 at the Central Research Station, Ben Hur Research Farm near Baton Rouge, LA. One study evaluated growth response of sugarcane to varying purple nutsedge tuber planting densities (density study) and the other study compared the competitiveness of sugarcane cultivars with purple nutsedge (cultivar study). For both studies 26.5 L pots with a surface area of 0.093m^2 were used and placed outside under a drip irrigation watering system that delivered 1.0 cm of water per day. The soil mixture used was one part sterilized Commerce silt loam (fine-silty, mixed, superactive, nonacid, thermic Fluvaquentic Endoaquepts), one part sterilized sand, and one part Jiffy Mix Plus[1].

In the density study, 0, 1, 2, 4, 8, and 16 purple nutsedge tubers were planted per pot along with one seed piece of LCP 85-384. In the cultivar study, LCP 85-384, Ho 95-988, HoCP 96-540, and L 97-128, were planted with 0 and 4 purple nutsedge tubers per pot. For each cultivar the seed piece was planted in the center of the pot at a 45^o angle to the ground with the bud facing upward at 1.3 cm below the soil surface. Purple nutsedge tubers were planted 5.1 cm deep and spaced evenly, using a grid to mark the locations, around the sugarcane seed piece. The experimental design for both the density and cultivar studies was a randomized complete block design with five replications. Plantings were made on August 9, 2005 and again on August 25, 2005. By 49 days after planting (DAP) it was apparent that soil volume in the pot was beginning to limit growth of purple nutsedge. Each study was terminated 64 DAP.

[1] A sterile soil mix with an optimal blend of sphagnum and vermiculite with MagAmp slow release fertilizer (7-40-6). Jiffy Products of America, Inc., 600 Industrial Parkway, Norwalk, OH 44857

For the density study, purple nutsedge shoot population was determined 14, 25, 38, 49, and 64 DAP. To quantify sugarcane response, shoot population was determined 49 and 64 DAP and primary sugarcane height was measured 38, 49, and 64 DAP. Sugarcane height for the primary shoot was measured from the soil surface to the last visible leaf collar. Also at 64 DAP, fresh weight shoot (above ground) biomass of both purple nutsedge and sugarcane was recorded and roots were washed free of soil and separated to determine fresh weight root (below ground) biomass for both purple nutsedge and sugarcane. Root weight of purple nutsedge also included tubers. Fresh weight samples were dried at 60 C for 48 hours and reweighed to determine root and shoot dry weight biomass of both purple nutsedge and sugarcane. Data also collected at this time were number of purple nutsedge tubers produced over the duration of each experiment for the density treatments.

In the sugarcane cultivar study, sugarcane primary shoot height for the four cultivars was measured 38, 49, and 64 DAP along with shoot population 49 and 64 DAP. Sugarcane height was determined as previously described. At 64 DAP, root and shoot dry weight biomass for both purple nutsedge and sugarcane and tuber population were determined as described for the density study.

Shade Study.

A purple nutsedge shade study was conducted in the summer of 2005 near Port Allen, LA, in an abandoned sugarcane field with a heavy, natural infestation of purple nutsedge. The soil type was a Commerce silt loam (fine-silty, mixed, superactive, nonacid, thermic Fluvaquentic Endoaquepts) with 1.8% organic matter and a pH of 6.5. The experimental design was a randomized complete block design with four replications and two experiments were conducted in 2005. The first experiment was initiated on May 25, 2005, and the second experiment was initiated on August 2, 2005. Shade levels of 0, 30, 50, 70, and 90% (100, 70, 50, 30, or 10% of full sun light) were based on the light interception levels of black polypropylene fabric[2] shading material. Shade intensities expressed as photosynthetically active radiation (PAR) with the polypropylene fabric were confirmed within three percent using an AccuPAR Linear PAR Ceptometer[3]. Shade enclosures (0.61 x 0.61 x 0.61m) were constructed using wood frames wrapped in polypropylene fabric on the four sides and top with the bottom left open.

The entire experimental area was tilled to a depth of 10.2 cm with a rotary tiller and treated with atrazine at 2.25 kg ai/ha plus pendimethalin at 2.13 kg ai/ha to eliminate competition from other weeds. Purple nutsedge shoot population and height data were collected 28, 42, and 56 days after tillage and placement of shade enclosures on the soil surface. At 56 days purple nutsedge height was measured from the base of the plant to the longest leaf tip on 10 randomly selected plants from each plot. Purple nutsedge plants under each enclosure were clipped at the soil surface and shoot fresh weight was determined. Shoots were dried at 60 C for 48 hours and reweighed to determine shoot dry weight biomass. An attempt was not made to quantify underground biomass.

Statistical Analysis.

[2] DeWitt Company, 905 S. Kings Highway, Sikeston, MO 63801
[3] Decagon Devices, Inc., 950 NE Nelson Court, Pullman, WA 99163

In both the competition and shade studies data were subjected to the Mixed Procedure in SAS[4]. Each experiment was considered an environment sampled at random as suggested by Carmer et al. (1989). Environment, replications (nested within environment), and all interactions containing either of these effects were considered random effects. All other variables were considered fixed effects. Considering experiments as environmental or random effects permits inferences about treatments to be made over a range of environments (Carmer et al. 1989; Hager et al. 2003). Type III statistics were used to test the fixed effects, and least square means were used for mean separation at $P \leq 0.05$. Letter groupings were converted using the PDMIX800 macro in SAS (Saxton 1998).

RESULTS AND DISCUSSION

Competition Studies.

In the density study, purple nutsedge growth and development was very rapid when exposed to optimal growing conditions in August when sugarcane would be planted in Louisiana. At 14, 25, and 38 DAP an increase in the number of purple nutsedge shoots was observed with each incremental increase in initial tuber density from 1 to 16/pot (Table 1). At 49 DAP, purple nutsedge shoot production increased as tuber density increased but differences were not observed between 4 and 8 tubers/pot. Shoot population 64 DAP was equal for 1 and 2 tubers/pot and for 4 and 8 tubers/pot, but in all cases shoot population was less than for the 16 tuber density (87.4 shoots/pot). From the first sampling date 14 DAP until the last sampling date 64 DAP, purple nutsedge shoot population increased 3.9 fold for the 16 tuber density and 19.5 fold for the 1 tuber density. The fact that shoot population increased less over time as tuber density increased is likely due to intraspecific competition (Williams et al. 1977).

At 64 DAP dry weight of both shoots and roots (including tubers) increased as initial tuber density increased (Table 1). For both variables, differences were not observed between 4 and 8 tubers/pot. For the tuber density treatments, purple nutsedge root dry weight averaged 3.4 times that of shoot dry weight, showing that partitioning of carbohydrate favored below ground growth over that of shoots. Tubers act as both source and sink of food materials, particularly of available carbohydrates and shoot formation occurs in succession (Singh and Singh 1981). In this study, root dry weight data included both roots and tubers. Although tuber weight was not determined, a sizeable percentage of the root dry weight was represented by tubers. This is supported by the tuber population present 64 DAP (Table 1). Tuber population increased with each incremental increase in tuber density. At 64 DAP, 37.3 tubers/pot were produced following an initial tuber density of 1/pot (37.3 fold increase) compared with 186.3 tubers/pot where the initial tuber density was 16/pot (11.6 fold increase), a 5 fold difference. The change in purple nutsedge tuber population with fewer tubers produced over time as the initial tuber density increased, as also noted for purple nutsedge shoot population, is a reflection of the intraspecific competition that occurred.

Shoot population of LCP 85-384 sugarcane at 49 DAP was reduced with all purple nutsedge tuber densities evaluated (Table 2). However, by 64 DAP, sugarcane shoot population was equivalent for the weed free control and for 1 and 2 tubers/pot (8.5 shoots/pot average) and greater than for 4 or more tubers/pot (4.9 shoots/pot average). Sugarcane primary shoot height

[4] SAS Institute. 2003. SAS User's Guide: Statistics. Version 9.1. SAS Institute. Cary, NC.

38, 49, and 64 DAP was not reduced at purple nutsedge densities of 1 or 2 tubers/pot (Table 2). However at initial tuber densities per pot of 4 or more, sugarcane height was reduced an average of 25 to 35% compared with the weed-free control at 38, 49, and 64 DAP. Reduction in sugarcane shoot dry weight 64 DAP was also observed, but only at the initial purple nutsedge densities per pot of 4 or more (average shoot weight reduction of 71% compared with the weed-free control (Table 1). Based on LCP 85-384 height and shoot weight, the critical weed density for purple nutsedge (density of nutsedge where reductions occurred vs. weed-free control) was 4 tubers/pot (40 tubers/m^2). In contrast, all tuber densities decreased sugarcane root dry weight compared with the weed-free control (Table 2). With 1 and 2 tubers/pot, sugarcane root dry weight was reduced an average of 50% and at the higher tuber densities was reduced an average of 85%. Based on LCP 85-384 root dry weight, the critical weed density for purple nutsedge was 1 tuber/pot (10 tubers/m^2). In developing alternative control strategies, it is important to know the critical weed density (Cousens 1991; Radosevich 1987). In sugarcane culture in Louisiana it would be important that sugarcane develops a root system adequate to sustain viability of plants into the winter period and that also would support aggressive emergence and growth of plants after the winter dormant period. This research shows that purple nutsedge is highly competitive with sugarcane, especially in regard to root development. Purple nutsedge control measures should be implemented at planting to ensure adequate sugarcane plant populations in the first production year.

In the sugarcane cultivar study a significant cultivar by initial tuber density interaction was not observed for any of the purple nutsedge parameters measured. Averaged across sugarcane varieties, purple nutsedge planted at an initial tuber density of 4/pot with a single sugarcane node segment produced 54.8 shoots and 113.9 tubers/pot in 64 d (data not shown). Purple nutsedge shoot and root dry weight was 20.6 and 64.7 g/pot, respectively. It should be noted that purple nutsedge shoot population, shoot and root dry weight, and tuber population data collected at the 4 tuber/pot density averaged across four sugarcane cultivars compares closely with data generated in the purple nutsedge and LCP 85-384 study discussed previously (Table 1).

In the sugarcane cultivar study averaged across initial tuber densities of 0 and 4 tubers/pot, L 97-128 height 49 and 64 DAP was greater when compared with LCP 85-384 and Ho 95-988, but equal to that of HoCP 96-540 (Table 3). Shoot population and shoot and root dry weight were equivalent for LCP 85-384, HoCP 96-540, and Ho 95-988. At 49 and 64 DAP shoot population for L 97-128 averaged 2.5 and 1.7 times that, respectively, of the other cultivars. Shoot and root dry weight 64 DAP for L 97-128 averaged 2.0 and 1.7 times that, respectively, of the other three cultivars. Of the sugarcane cultivars evaluated L 97-128 was the first to emerge and produce tillers. This combined with the ability of L 97-128 to rapidly establish a root system would enhance its competitive advantage with purple nutsedge. Averaged across sugarcane cultivars, 4 purple nutsedge tubers/pot resulted in a decrease in all sugarcane growth parameters when compared with the weed free control (Table 3). At 64 DAP, sugarcane height, shoot population, and shoot and root dry weight biomass were decreased 21, 45, 62, and 71%, respectively. Results indicate that even though L 97-128 was more competitive with purple nutsedge than the other cultivars, growth of L 97-128 was still greatly affected by weed competition.

Shade Study.

For 30% shade, the lowest shade level imposed, purple nutsedge shoot population was reduced 35, 34, and 53% at 28, 42, and 56 days, respectively, compared with the full sunlight (no shade) control (Table 4). Purple nutsedge height at 56 days was not negatively affected by 30 or 50% shade, but shoot dry weight was reduced for all shade levels. Compared to full sunlight, shoot population, height, and shoot dry weight were each equivalent for 30 and 50% shade treatments. Santos et al. (1997) reported that after 50 days, 40% shading reduced purple nutsedge shoot number by 47% and shoot dry weight by 67%. Patterson (1982) reported that after 62 days 40% shading reduced purple nutsedge shoot number by 61% and total dry weight by 67%. Reductions in shoot population and dry weight noted in their studies approximate those observed in the present study. Purple nutsedge shoot population, height, and shoot dry weight in the present study were each equivalent for the 70 and 90% shade treatments. Shoot population and shoot dry weight at 56 days for the 70 and 90% shade treatments were reduced an average of 82 and 92%, respectively, compared with full sunlight. In contrast, purple nutsedge height at 56 days for the 70 and 90% shade treatments increased an average of 38% compared with full sunlight.

Since this was a field study no attempt was made to quantify effects of shade on purple nutsedge root weight or tuber production. It is noteworthy, however, that purple nutsedge was able to persist under a 90% shade environment for 56 days. In research conducted from June through August in Louisiana to evaluate shading potential of sugarcane cultivars, average PAR reduction (shade) at ground level under a crop canopy was greatest for L 97-128 and L 99-226 (around 80%), intermediate for Ho 95-988 and L 99-233 (around 74%), and lowest for LCP 85-384 and HoCP 96-540 (58%) (Bittencourt et al. 2010). Based on these results and those from the shade study, PAR under the sugarcane canopy would be sufficient to sustain growth of purple nutsedge and may help explain why purple nutsedge is becoming more problematic in Louisiana sugarcane.

Results clearly show that purple nutsedge can be highly competitive with sugarcane at planting in August and September. In 64 DAP a 37.3 fold increase in purple nutsedge tuber population occurred when only one tuber/0.093m^2 was planted with a single node segment of LCP 85-384 sugarcane (Table 1). At the lowest density evaluated of one tuber/0.093m^2 sugarcane root dry weight was reduced 45%, but shoot dry weight was not affected (Table 2). An initial tuber density of 4 tubers/0.093m^2 was needed to reduce sugarcane shoot dry weight. In Brazil, full season competition of high populations of purple nutsedge (160 plants/0.1m^2 at 5 to 7 weeks after planting) resulted in significant losses in transplanted vegetable crops (William and Warren 1975). In comparing competitiveness of sugarcane cultivars with purple nutsedge, L 97-128 produced more shoots and greater shoot and root dry weight when compared with LCP 85-384, Ho 95-988, and HoCP 96-540 (Table 3). Based on shoot and root dry weight after 64 d of competition with purple nutsedge, L 97-128 was at least twice as competitive as the other cultivars. Purple nutsedge shoot dry weight was reduced by 75% when grown under 30% shade for 56 days and purple nutsedge was able to persist under 90% shade (Table 4).

Since preemergence herbicides applied at planting in sugarcane have little activity on purple nutsedge, effective postemergence herbicides to include halosulfuron or trifloxysulfuron (Anonymous 2009) should be applied around 4 to 6 weeks after planting to reduce the negative effect of purple nutsedge on sugarcane root development. It is critical to sugarcane stand establishment that a sufficient root system is produced that will sustain plants through the winter dormant period and that will promote aggressive re-emergence and growth of sugarcane in the spring. In the spring of the year cool soil temperatures around 18 C (Anonymous 2006) are not optimal for germination and growth of purple nutsedge from tubers (Aleixo and Valio 1976; Shamsi et al. 1978; Ueki 1969). The ability of sugarcane to produce significant growth and shading in the spring before purple nutsedge tubers germinate would further reduce purple nutsedge competition.

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Table 1. Purple nutsedge growth response to co-planting of several tuber densities with a single node segment of 'LCP 85-384' sugarcane.[1]

Initial tuber density	Shoot population					Shoot dry weight 64 DAP	Root dry weight 64 DAP	Tuber population 64 DAP
	14 DAP	25 DAP	38 DAP	49 DAP	64 DAP			
no./pot	---no./pot---					---g/pot---		no./pot
0	0 e[2]	0f	0 f	0 e	0 d (0)[3]	0 e	0 e	0 f (0)[4]
1	1.3 e	5.1 e	8.4 e	13.0 d	25.3 c (19.5)	6.7 d	22.4 d	37.3 e (37.3)
2	3.4 d	11.0 d	16.1 d	20.3 c	37.0 c (10.9)	13.4 c	39.4 e	66.4 d (33.2)
4	7.5 c	23.5 c	29.3 c	33.8 b	58.1 b (7.7)	20.4 b	70.0 b	114.8 e (28.7)
8	12.5 b	30.7 b	35.9 b	38.7 b	59.3 b (4.7)	20.8 b	72.4 b	137.2 b (17.2)
16	22.7 a	45.6 a	51.8 a	57.9 a	87.4 a (3.9)	27.4 a	102.7 a	186.3 a (11.6)

[1] Nutsedge and sugarcane planted in August in 26.5 L pots with a surface area of $0.093 m^2$. Pots were placed outside under a drip irrigation watering system. Root dry weight represents both roots and tubers. DAP = days after planting.
[2] Data represent an average across two experiments. Treatment means within each column followed by the same letter are not significantly different ($P > 0.05$). Letter groupings were converted using the PDMIX800 macro in SAS (Saxton 1998).
[3] Values in parentheses represent the increase in purple nutsedge shoot population from 14 to 64 DAP. For example 19.5 = 19.5 fold increase from 14 to 64 DAP.
[4] Values in parentheses represent the increase in purple nutsedge tuber population from the initial tuber density to 64 DAP. For example 37.3 = 37.3 fold increase.

Table 2. Sugarcane growth response to co-planting of a single node segment of 'LCP 85-384' sugarcane with several purple nutsedge tuber densities.[1]

Initial tuber density	Shoot population		Height			Shoot dry weight	Root dry weight
	49 DAP	64 DAP	38 DAP	49 DAP	64 DAP	64 DAP	64 DAP
no./pot	---no./pot---		---cm---			---g/pot---	
0	4.8 a[2]	8.6 a	15.2 a	21.6 a	30.2 a	28.5 a	14.6 a
1	2.2 b	8.5 a	13.4 a	20.9 a	30.0 a	24.2 a	8.0 b
2	1.8 b	8.5 a	13.3 a	20.8 a	29.5 a	22.1 a	6.7 b
4	0 c	5.4 b	9.8 b	15.8 b	24.1 b	10.0 b	2.9 c
8	0.4 c	4.8 b	10.4 b	15.2 b	22.1 b	7.9 b	1.9 c
16	0 c	4.6 b	9.3 b	14.9 b	21.6 b	6.7 b	1.6 c

[1] Nutsedge and sugarcane planted in August in 26.5 L pots with a surface area of $0.093 m^2$. Pots were placed outside under a drip irrigation watering system. DAP = days after planting.
[2] Data represent an average across two experiments. Treatment means within each column followed by the same letter are not significantly different ($P > 0.05$). Letter groupings were converted using the PDMIX800 macro in SAS (Saxton 1998).

Table 3. Sugarcane growth response to co-planting of a single node segment of four sugarcane varieties with 4 purple nutsedge tubers/pot.[1]

Cultivar[2]	Height 38 DAP	Height 49 DAP	Height 64 DAP	Shoot population 49 DAP	Shoot population 64 DAP	Shoot dry weight 64 DAP	Root dry weight 64 DAP
	--------------------cm--------------------			------------no./pot-----------		-------------g/pot-------------	
LCP 85-384	14.7 ab[3]	18.7 bc	27.6 b	2.4 b	7.3 b	18.2 b	8.5 b
Ho 95-988	12.2 b	17.7 c	25.7 b	2.0 b	7.6 b	21.2 b	7.4 b
HoCP 96-540	12.5 b	21.5 ab	29.7 ab	2.3 b	6.1 b	22.8 b	9.7 b
L 97-128	16.0 a	22.2 a	33.2 a	5.6 a	11.7 a	41.5 a	14.6 a

Initial tuber density[2]							
no./pot	--------------------cm--------------------			------------no./pot-----------		-------------g/pot-------------	
4	11.9*[4]	17.7*	25.6*	1.1*	5.8*	14.2*	4.5*
	(25%)	(21%)	(21%)	(77%)	(45%)	(62%)	(71%)

[1] Purple nutsedge and sugarcane planted in August in 26.5 L pots with a surface area of 0.093m^2. Pots were placed outside under a drip irrigation watering system. DAP = days after planting.
[2] Significant sugarcane cultivar and tuber density main effects were observed but the cultivar x tuber density interaction was not significant for any of the parameters measured.
[3] Data represent an average across two experiments and tuber densities of 4 and 0 tubers/pot. Treatment means within each column followed by the same letter are not significantly different (P > 0.05). Letter groupings were converted using the PDMIX800 macro in SAS (Saxton 1998).
[4] Data averaged across sugarcane varieties for the initial tuber density of 4 tubers/pot. An asterisk (*) denotes that data were significantly different from the weed free (0 tubers/pot) treatment. Values in parentheses represent percent reduction versus the weed free control.

Table 4. Purple nutsedge growth response to shade.[1]

	Shoot population			Height	Dry weight
Shade level	28 days	42 days	56 days	56 days	56 days
%	--------------------no./0.37m²	------------------		cm	$g/0.37m^2$
0	36.5 a[2]	77.8 a	136.0 a	23.7 c	46.1 a
30	23.6 b	51.5 b	64.1 b	21.5 c	11.6 b
50	15.4 bc	33.3 bc	52.8 b	25.1 bc	7.6 bc
70	9.9 c	19.8 c	21.5 c	31.7 ab	3.2 c
90	8.8 c	20.3 c	28.6 c	33.9 a	4.1 c

[1]Shade enclosures (0.61 x 0.61 x 0.61m) were constructed of wood and wrapped in polypropylene fabric shading material on four sides and top. Shade enclosures were placed on the soil after the experimental area was tilled to a depth of 10.2 cm using a rotary tiller. Data were collected 28, 42, and 56 days after tillage and placement of shade enclosures and represent an average across two experiments.
[2] Data represent an average across two experiments. Treatment means within each column followed by the same letter are not significantly different ($P > 0.05$). Letter groupings were converted using the PDMIX800 macro in SAS (Saxton 1998).