YELLOW NUTSEDGE GROWTH IN RESPONSE TO ENVIRONMENT

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Introduction

Yellow nutsedge is a perennial weed common in irrigated row crop production in the Treasure Valley of eastern Oregon and southwestern Idaho. It is particularly problematic in onion production. Onions are relatively short statured plants with vertical leaves producing an incomplete canopy with limited potential to effectively suppress weeds. Yellow nutsedge has a C_4 photosynthetic pathway and therefore responds well to conditions of high light intensity that exist in onion production. Management practices including frequent irrigation and high nitrogen fertilization required to maximize onion yield also serve to stimulate yellow nutsedge growth (Keeling et al. 1990).

Yellow nutsedge reproduces and is dispersed primarily by tubers' that are formed at the apical ends of underground rhizomes. Tubers are produced in the upper 18 inches of the soil profile with the greatest concentration located in the upper 6 inches (Stoller and Sweet 1987, Tumbleson and Kommedahl 1961). After a period of dormancy, tubers germinate and produce shoots in subsequent growing seasons. Tubers may remain viable for 1-3 years, providing an effective means of survival. Asexual reproduction by yellow nutsedge tubers can be quite prolific. Tumbleson and Kommedahl (1961) reported that a single tuber produced 6,900 tubers the first fall after planting and 1,900 plants the following spring in an area of approximately $34ft^2$. Yellow nutsedge grows best where soil moisture is high (Bendixin and Nandihalli 1987). Garg et al. (1967) reported that nitrogen promotes vegetative growth over reproductive growth in yellow nutsedge, leading to increased basal bulb formation (and subsequent shoot production) as opposed to tuber formation.

Two trials were conducted in 2004 at the Malheur Experiment Station to evaluate yellow nutsedge growth with various environmental factors.

Methods

Yellow nutsedge emergence and growth as influenced by depth of germination

The objectives of this experiment were to 1) determine the depth from which a yellow nutsedge tuber can emerge in the field, 2) determine the date of emergence based on depth of burial, and 3) determine the growth (i.e., shoot and tuber production) potential based on burial depth.

Yellow nutsedge tubers were harvested from a plot from the previous year's irrigation trial on April 16, 2004. The tubers were washed from the soil, rinsed with deionized water, and placed in a refrigerator at 38.5°F for approximately 14 days. Both washing and chilling have been shown to effectively break tuber dormancy (Tumbleson and Kommedahl 1961, Bell et al. 1962). This was necessary to ensure that the tubers would readily germinate when buried and that any differences in emergence would be based on depth of burial and/or soil temperature and not differences in dormancy. Ten tubers were buried in a single container at a selected depth of either 2, 4, 6, 8, 10, 12, 14, 16, 18, or 24 inches on May 1. Each depth was replicated four times. Containers consisted of 10-inch-diameter pvc pipe. Temperature sensors were placed at 6, 12, 18, and 24 inches deep in 1 tube in each replication. Each container was irrigated by a single drip emitter with an output of 0.5 gal/hr. Watermark sensors (Irrometer Co. Inc., Riverside, CA) were buried 6 inches deep in every pot in the first and third replicate of the trial. Soil water potential was measured every morning. Irrigations were initiated each time the average of the Watermark sensors was greater than or equal to -20 kPa. Shoots were counted throughout the season and shoots and tubers were harvested on July 7.

Yellow nutsedge growth in response to irrigation and nitrogen fertilization
The objectives of this experiment were to 1) monitor patch expansion from a single yellow nutsedge tuber in the absence of crop competition over the course of one growing season, 2) evaluate the effects of selected irrigation regimes on yellow nutsedge growth, and 3) evaluate the effect of nitrogen fertilization on yellow nutsedge growth.

Tubers for this trial were harvested from a ditch bank, were washed from the soil, rinsed with deionized water, and stored in a refrigerator at 38.5°F for approximately 40 days. Tubers weighing from 0.18 to 0.2 g and measuring between 6 and 7 mm were selected and planted in flats in the greenhouse. Tubers of similar size and weight were selected because research has shown that tuber size can affect early plant vigor, with plants from smaller tubers being less vigorous. On June 4, a single germinated tuber with a shoot of at least 1 inch long was transplanted into the center of each circular plot of 6-ft diameter. Transplanted yellow nutsedge plants were used to ensure a more uniform date of establishment among the 18 individual plots. The circular plots consisted of 14-inch-wide galvanized valley flashing cut to a length of 19 ft with the ends riveted together to produce a circle with a diameter of 6 ft. The flashing was then buried approximately 10 inches deep in the soil. Prior to transplanting, each plot was drip irrigated to a soil moisture potential of -20 kPa to incorporate fertilizer applications and to provide similar moisture conditions for early yellow nutsedge establishment.

The trial consisted of 18 circular plots, 6 each for the 3 irrigation regimes and 3 each for the 2 fertilization levels split over the irrigation regimes. Irrigation water was applied to the plots through 6 drip emitters evenly spaced in a circular pattern, where each emitter was located 1.5 ft from the center of the plot. The 6 emitters had a combined output of 3.0 gal/hr. The values for irrigation criteria were -20, -50, and -80 kPa and were selected to represent soil moisture conditions similar to those in wheat, sugar beet, and dry bulb onion production systems, respectively. The 2 fertilization levels consisted of plots receiving nitrogen (N) (46 percent urea) at rates of either 90 or 268 lbs N/acre. All plots were fertilized before transplanting with 90 lbs phophorus/acre, 90 lbs sulfur/acre, 1 lb copper/acre, 1 lbs boron/acre, and 9 lbs magnesium/acre. Soil water potential was measured in each plot with a single Watermark soil moisture sensor installed at a 6-inch depth equidistant from the yellow nutsedge plant at the center of the plot and the drip line. Irrigation water was applied independently for each regime when the average 6-inch soil water potential from the 6 sensors reached either -20, -50, or -80 kPa. The sensors were read by a datalogger every 3 hours, and once every 12 hours irrigation was initiated using a solenoid valve if the soil water potential had exceeded the treatment criteria during the previous 12-hour period. Water meters were installed between the solenoid valves and the water line for each individual irrigation regime to record the amount of water applied daily.

Yellow nutsedge growth was measured initially by counting shoot numbers within each plot and by taking overhead digital images of each plot. At a point where shoots became too numerous to efficiently count, only overhead digital images were taken of each plot. These images were used to quantify the plot area that was covered by yellow nutsedge shoots using a software program produced at Oregon State University (OSU). Shoots and tubers were harvested from subsamples within each plot on September 29 and 30. Thirteen subsamples were collected across the 6-ft diameter of the plots. The subsamples consisted of 4.25-inch-diameter circles from which shoots were counted to estimate the total shoot number per plot. The shoots were then clipped at ground level and placed in bags to be dried. The dry weights were used to estimate the total above-ground biomass. Once the shoots were removed, a soil core measuring 4.25 inches in diameter by 8 inches in depth was taken from the same area where the shoots were removed. The individual core samples were bagged and recorded as to their location within the plot. The core samples were then emptied into a bucket with multiple 11/64-inch holes in the bottom and sides. Water was sprayed into the bucket to remove the soil from the tubers. The tubers were then counted and weighed and those numbers were used to estimate the total tuber population for each of the plots.

Results and Discussion

Yellow nutsedge emergence and growth as influenced by depth of germination

Plots where tubers were planted from 2 to 12 inches deep had an average of 1-5 shoots emerged on May 24, while deeper depths had no shoots for another week or more (data not shown). The time required for treatments to produce an average 5 shoots per plot ranged from 24 to 68 days after planting. The time required for 10 shoots per plot to emerge ranged from 34 to 55 days for burial depths up to 18 inches. The tubers buried at the 24-inch depth produced a maximum of 6 shoots at the time the plots were harvested. The average daily soil temperatures at 6, 12, 18, and 24 inches from planting through harvest are illustrated in Figure 1 and show that temperature extremes are greatest nearer the soil surface. If tubers were buried earlier in the year, we might expect to see greater differences among emergence dates based on differences in the time required for the soil at each depth to reach temperatures favorable for yellow nutsedge germination. Figure 2 shows the emergence of shoots as affected by planting depth from May 24 through June 7. At harvest, shoot numbers were similar in plots where tubers were planted from 2 to 16 inches deep (Table 1). Tubers planted 18 and 24 inches deep had fewer shoots than all other planting depths and the 24-inch depth had the least number of shoots. The average weight per shoot was less for 16-, 18-, or 24-inch depths compared to depths from 2 to 12 inches (data not shown). Tuber numbers were lower for plots where the planting depth was 14 inches or greater, with significant decreases as depth increased from 12 to 24 inches.

This research demonstrates that yellow nutsedge shoot emergence is delayed at depths below 12 inches. Those shoots that emerge are fewer in number and at depths below 16 inches are also smaller in size. This delay in emergence affects how many tubers can be produced, and it is reasonable to expect that the delay in emergence and reduction in individual shoot fitness would correlate with reduced competitiveness from yellow nutsedge emerging from depths greater than 14 inches in the soil.

Table 1. Yellow nutsedge shoot emergence and shoot and tuber production as influenced by depth of germination, Malheur Experiment Station, Oregon State University, Ontario, OR, 2004.

Depth of burial	Time to emergence: Average ≥ 5 shoot/container†	Average ≥ 10 shoot/container‡	Yellow nutsedge production*: Shoots	Tubers
	--------- days after planting -----------		------------no/plot-----------	
2-inch	35	41	91 b	250 b
4-inch	25	39	115 ab	334 a
6-inch	24	34	101 ab	333 a
8-inch	27	39	126 a	313 ab
10-inch	27	39	108 ab	240 b
12-inch	31	39	119 a	272 ab
14-inch	39	40	119 a	167 c
16-inch	39	45	108 ab	97 cd
18-inch	45	55	66 c	30 de
24-inch	68	> 68	6 d	10 e

*Yellow nutsedge tubers were buried at the various depths on May 1, 2004, and yellow nutsedge shoots and tubers were harvested on July 7, 2004. Data followed by the same letter are not signficicant according to LSD (0.05).
†Days after planting for which the average of the 4 replicates for the given depth of burial were greater than or equal to 5.
‡Days after planting for which the average of the 4 replicates for the given depth of burial were greater than or equal to 10.

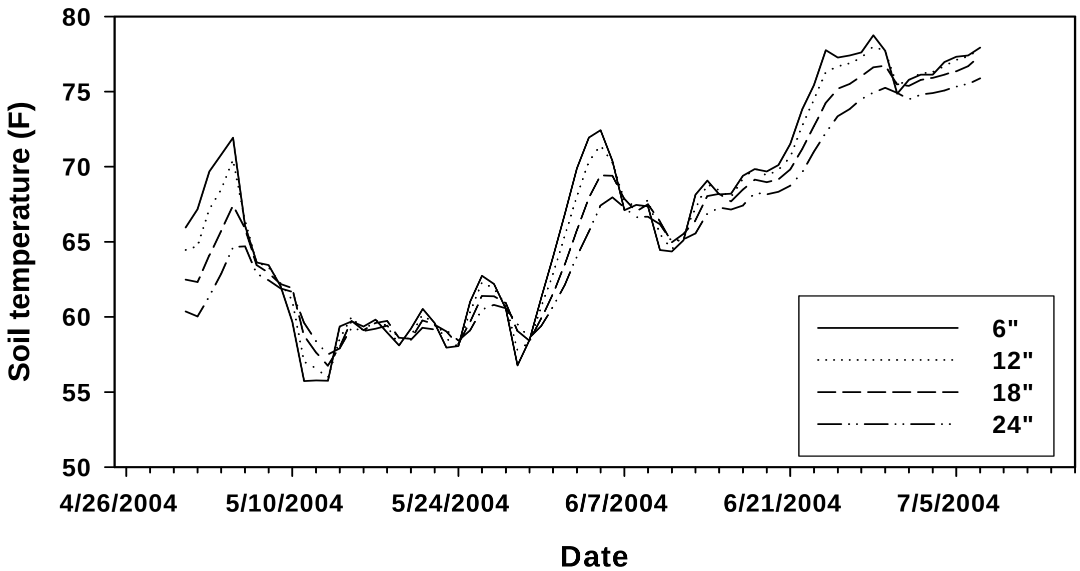

Figure 1. Average daily soil temperature at 6-, 12-, 18-, and 24- inch depths from yellow nutsedge tuber planting up to shoot and tuber harvest, Malheur Experiment Station, Oregon State University, Ontario, OR, 2004.

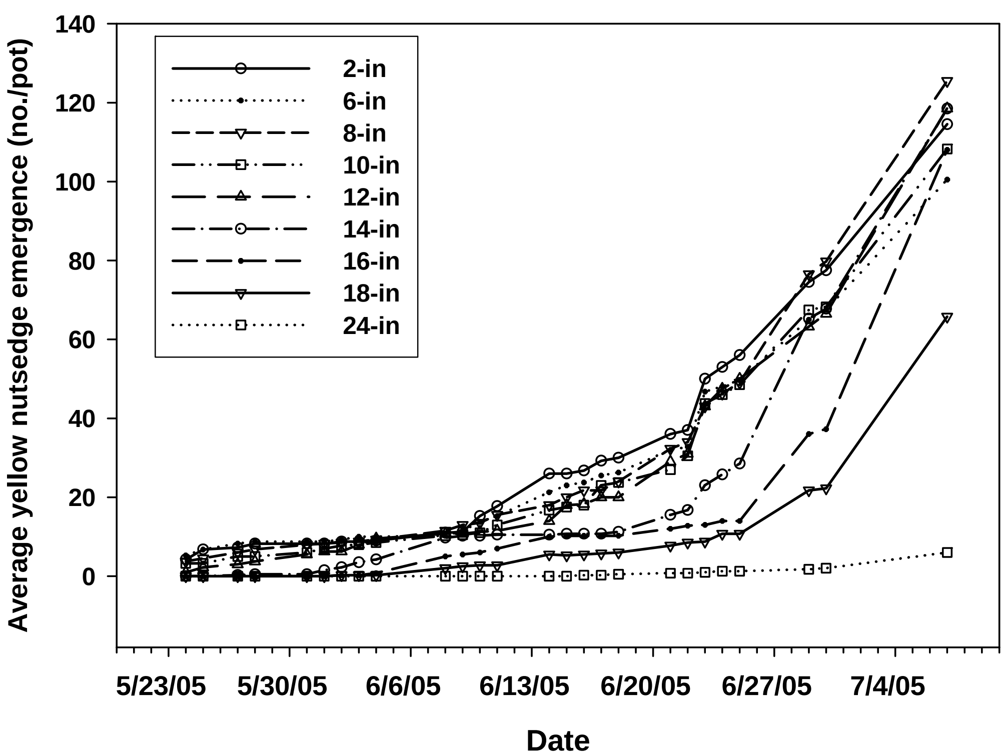

Figure 2. Yellow nutsedge shoot emergence over time as influenced by depth of germination, Malheur Experiment Station, Oregon State University, Ontario, OR, 2004.

Yellow nutsedge growth in response to irrigation and nitrogen fertilization
There were no significant interactions between irrigation criteria and fertilization. Nitrogen fertilization did cause a significant increase in shoot number, but not on shoot biomass, tuber number, total tuber weight per plot, or individual shoot or tuber weight (data not shown). Since there were no interactions, irrigation criteria data were averaged over fertilization levels. Irrigation events and total water applied are shown in Table 2. The number of irrigations and the total amount of water applied were much less for the -20-kPa and –50-kPa irrigation treatments compared to 2003. This may have been because temperatures were lower in 2004 compared to 2003. Soil moisture potential over time by irrigation regime is illustrated in Figure 3. Irrigation had a significant effect on yellow nutsedge shoot number and total weight (Table 3). The –20-kPa irrigation treatment produced an average of 1,747 shoots per plot. This was significantly greater than the –50-kPa and –80-kPa irrigation treatments, which produced 444 and 411 shoots per plot, respectively. All shoot numbers were much lower than in 2003. The –50-kPa and –80-kPa treatments produced similar numbers of shoots, while in 2003 the –50-kPa treatment produced almost twice as many shoots as the –80-kPa treatment. The –20-kPa irrigation treatment produced an average of 2.7 lb of shoot biomass per plot and the shoots in this treatment had higher weight per shoot than in the other irrigation treatments. Based on the digital images, the area infested by the yellow nutsedge shoots grew quickest for the –20-kPa treatment and much slower with either the –50- or –80-kPa treatments (Fig. 4). Similar to 2003, the amount of area infested was fairly small from June 4 to July 19. Over a 27-day period from July 21 to August 17 the area infested by yellow nutsedge in the –20-kPa treatments increased from 2.6 to 22.6 ft^2. Yellow nutsedge tuber production was higher with the –20-kPa irrigation criterion compared to the other irrigation criteria and total numbers for this treatment were similar to 2003 (Table 4). An average of 19,508 tubers/plot were produced from a single plant with the –20-kPa treatment. The –50- and –80-kPa treatments produced 4,447 and 5,826 tuber, respectively. The –50-kPa treatment produced 10,000 fewer tubers in 2004 than in 2003.

This year's results demonstrate that under high levels of irrigation yellow nutsedge can produce large numbers of shoots and tubers. This continues to be much higher than previously reported in the literature. However, the differences between 2003 and 2004 suggest that factors other than irrigation criteria may significantly affect the productive potential of yellow nutsedge when irrigation levels are moderate.

Table 2. Number of irrigations, amount applied per irrigation, and total water applied, Malheur Experiment Station, Oregon State University, Ontario, OR, 2004.

Irrigation criteria	Irrigations		Total applied*
kPa	number/plot	inches/event	inches/plot
-20	45	0.32	15.9
-50	7	1.0	8.5
-80	4	1.38	7.0

*Total includes 1.48 inch of rainfall.

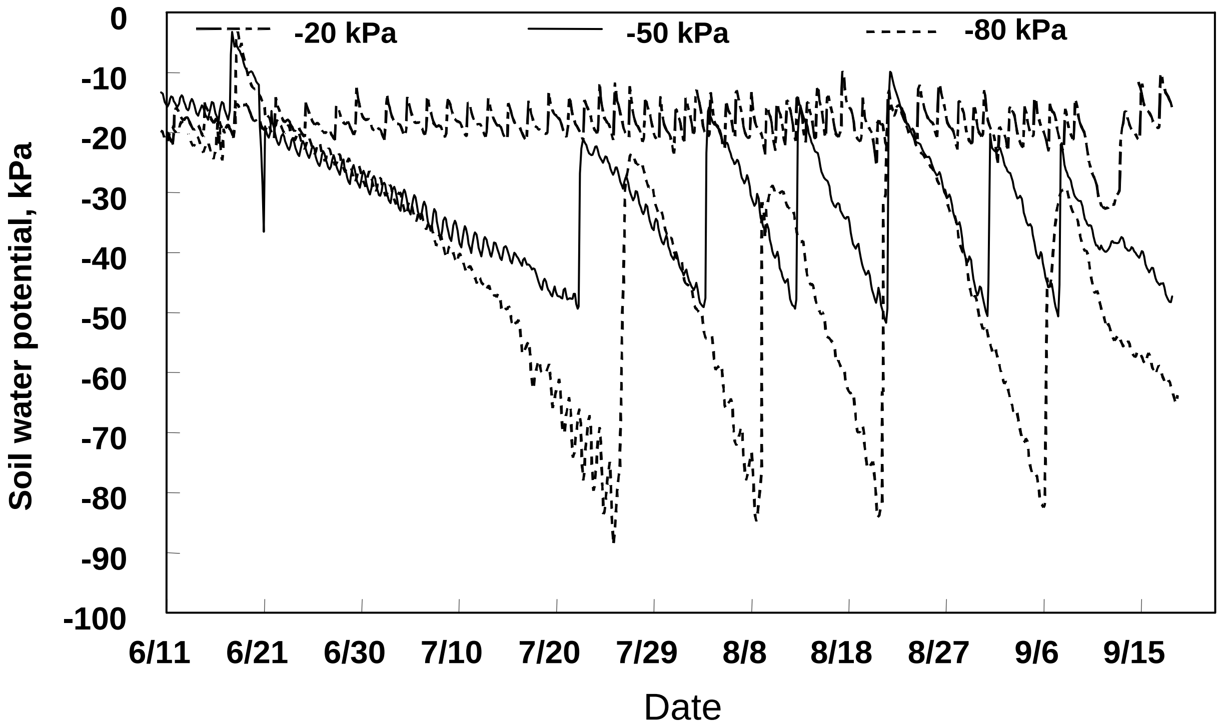

Figure 3. Soil moisture potential over time by irrigation regime, Malheur Experiment Station, Oregon State University, Ontario, OR, 2004.

Table 3. Yellow nutsedge shoot production as influenced by irrigation, Malheur Experiment Station, Oregon State University, Ontario, OR, 2004.

Irrigation	Yellow nutsedge shoots*				
kPa	no./plot	no./ft^2	lb/plot	lb/ft^2	g/shoot
-20	1,747 a	62 a	2.7 a	0.095 a	0.71 a
-50	444 b	16 b	0.5 b	0.019 b	0.51 b
-80	411 b	15 b	0.5 b	0.018 b	0.56 b

*Values followed by the same letter designation are not statistically different (P = 0.05).

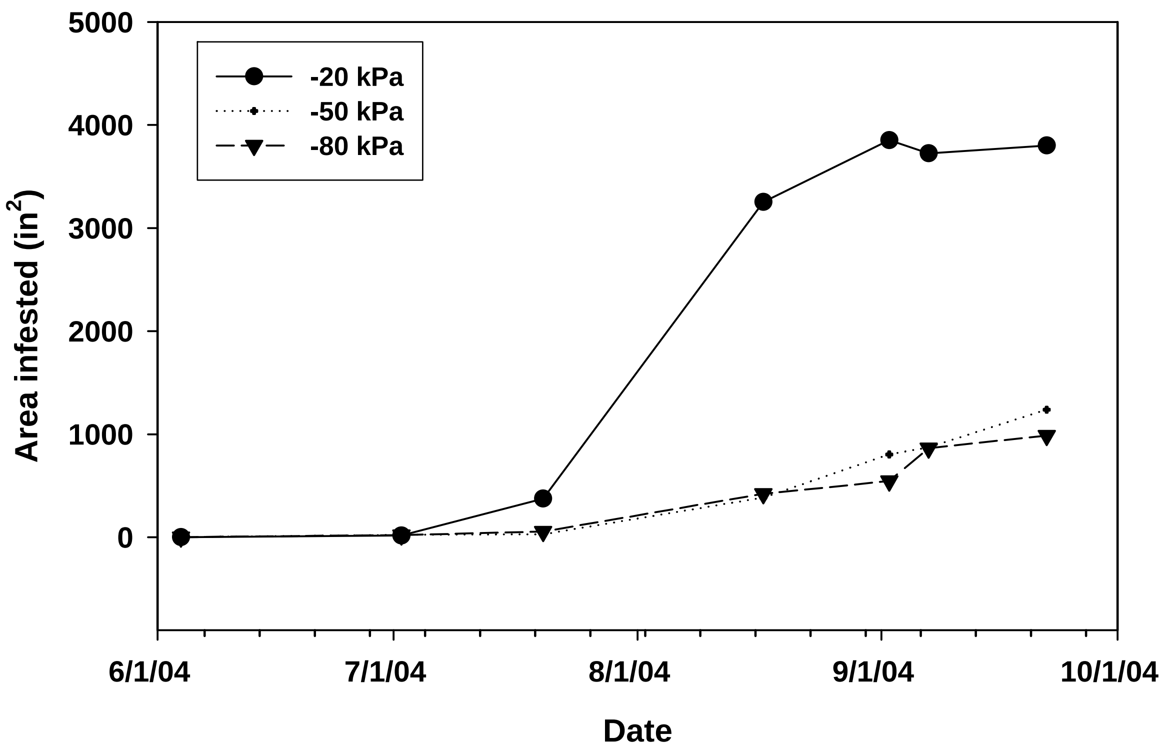

Figure 4. Yellow nutsedge patch expansion over time based on percent ground coverage between transplanting and harvest, Malheur Experiment Station, Oregon State University, Ontario, OR, 2004.

Table 4. Yellow nutsedge tuber production as influenced by irrigation, Malheur Experiment Station, Oregon State University, Ontario, OR, 2004.

Irrigation	Yellow nutsedge tubers				
kPa	no./plot	no./ft^2	lb/plot	lb/ft^2	g/tuber
-20	19,508 a	690 a	5.1 a	0.18 a	0.12 b
-50	4,447 b	157 b	1.5 b	0.005 b	0.15 a
-80	5,826 b	207 b	1.7 b	0.006 b	0.13 b

*Values followed by the same letter designation are not statistically different (P = 0.05).

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