Giant Foxtail

Setaria Faberi Herrm.

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Contents

Early History and Introduction into the United States

The exact origin of giant foxtail [*Setaria faberi* Herrm.]* is not known. Li, Pao, and Li (70) have suggested that perhaps this tetraploid originated from an ancient cross of green foxtail [*Setaria viridis* (L.) Beauv.] with an unknown diploid species. Wolfgang Herrmann, a German botanist, provided the first known botanical description of this species in 1910 (46). His description was based on a plant collected from the Szechwan province of China sometime between 1885 and 1891 by Reverend Ernst Faber, a missionary.

Chase (18) reports that seed of giant foxtail was found by seed analysts in 1932 in millet imported from China. Although it has been suggested that millet imported from China during our drought years of the 1930s may have been the primary source of giant foxtail introduced into the United States, the species was actually present earlier (30,32). One collection was made on September 19, 1925, on Long Island, New York, and another near Philadelphia on September 9, 1931 (94).

The introduction of the plant may have occurred earlier still. Plant explorers brought the seed of many plants, including millet, from the Orient in the early 1900s, and several varieties of millet were raised at Arlington Farm, Virginia, between 1909 and 1925 (90). It may be coincidence, but giant foxtail was subsequently reported growing near a greenhouse at Arlington Farm in 1936 (1).

A translation of Herrmann's Latin description of the plant collected by Faber does not appear to indicate fine pubescence on the upper leaf surface as usually associated with giant foxtail in the United States. Actual inspection of Faber's plant in an herbarium in Vienna, Austria, in 1985, failed to reveal the fine pubescence. Reports from several U.S. weed scientists visiting China suggest difficulty in finding plants with the characteristic leaf pubescence.

A letter dated July 9, 1989, from Professor Yang-han Li of the Weed Research Laboratory of Nanjing Agricultural University indicates that giant foxtail does occur in several parts of China as a common but not serious annual weed. Professor Y.L. Keng, a well-known taxonomist of grass in China, indicates that some plants referred to as *Setaria faberi* in China have the characteristic pubescence on the upper leaf surface while others do not. It is not unusual to have some variation within a species.

It is difficult to be certain that giant foxtail was introduced into the United States from China. The majority of evidence thus far, however, suggests this probability.

*The original species designation for giant foxtail was *Setaria faberii* Herrm. However, the Terminology Committee of the Weed Science Society of America changed the spelling to *Setaria faberi* Herrm. The latter is the current official designation.

Rapid Spread

Regardless of the exact source or reason for introduction, giant foxtail soon became well established in the United States. Giant foxtail's rapid adaptation may have been partly because the land elevation, soils, and climate in this plant's native China resembled those features in some of the agricultural areas in the United States where the plant eventually became established (53). Some reports suggest giant foxtail's spread along railroads in the United States (32,94). The seed also serves as a food for wild birds, which may have contributed to the plant's spread.

During the 1940s, giant foxtail continued to spread and became established as a weed. By the 1950s, the plant was quite prevalent in the Midwest (29,48,49,91). In Illinois, for example, the first collection reported was in 1938; by 1955, giant foxtail had spread to most counties of the state (48). Nationwide, also in the 1950s, the plant was present from Connecticut to South Dakota and from Minnesota to Missouri, Kentucky, and North Carolina (29,32, 49,91,126). Giant foxtail was soon considered to be the most serious annual grass weed in many agricultural production areas.

The advent of 2,4-D as a herbicide for corn in the late 1940s, and the broadleaf weed control it provided, may have afforded more opportunity for giant foxtail to become established (59). The trend from check-planted corn to hill-dropped corn and drilled corn, along with the subsequent reduction in cross-cultivation, may also have contributed to the spread of giant foxtail (53). The increasing and extensive acreage of corn and soybeans with life cycles similar to that of giant foxtail may have also favored giant foxtail.

Fortunately, the introduction of selective, soil-applied preemergence herbicides in the late 1950s offered control of giant foxtail, which resulted in the rapid adoption of their use. In some areas, use of soil-applied herbicides increased dramatically from treatment of 5 percent of the row crop acreage in 1960 to treatment of nearly all acreage by 1980.

Today, giant foxtail is found in the United States primarily in the Midwest, the East, and portions of the South. The plant's range extends from New England to the Great Plains, from Minnesota to Louisiana, to Georgia and the Carolinas (Figure 1).

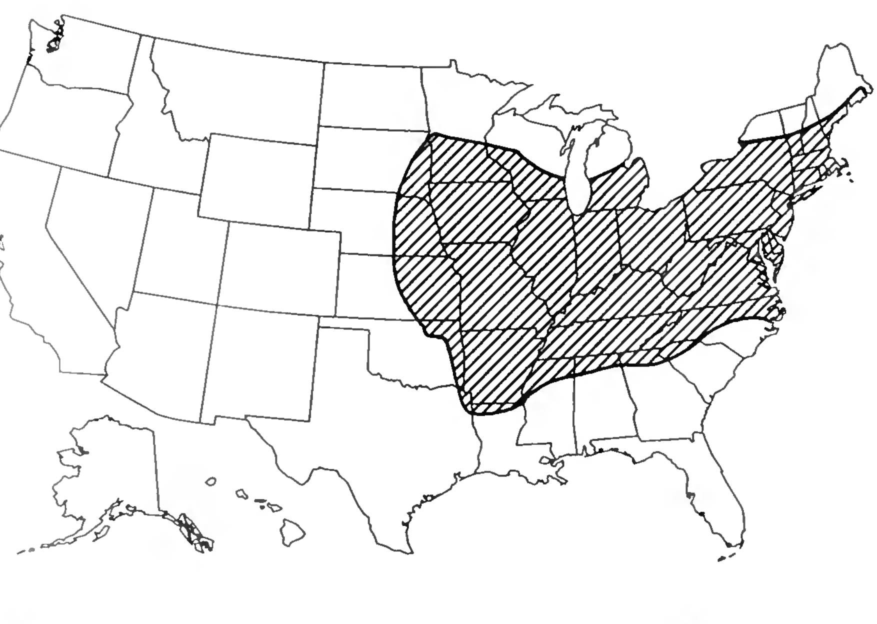

Figure 1. The distribution of *Setaria faberi* Herrm. is indicated on the shaded portion of the map. The map is based on communication with weed scientists and taxonomists during 1988-1989.

Growth Habits and Characteristics

In the Midwest, giant foxtail usually begins to emerge about mid-April (45,53). The seed is relatively small (2 to 3 mm). Emergence has been reported from seed at a depth of 4 or 5 inches (51,53). But most problems are caused by seed located in the top 2 inches of the soil (53). When mean daily soil temperature reaches about 50°F to 60°F, plants may emerge within a week to 10 days after the soil is disturbed or the seed is planted. Morré and Fletchall (74) found germination to be comparable at various temperatures between 59°F and 86°F. When seeded 1 inch deep on May 8 at Urbana, Illinois, seedlings emerged in 8 to 10 days. At 2 weeks, seedlings were 1/2 to 1 inch tall with two leaves. At 3 weeks, plants had three to four leaves, and at 4 weeks, they had five to six leaves. At 5 weeks, plants were tillering and crown roots were becoming established (53).

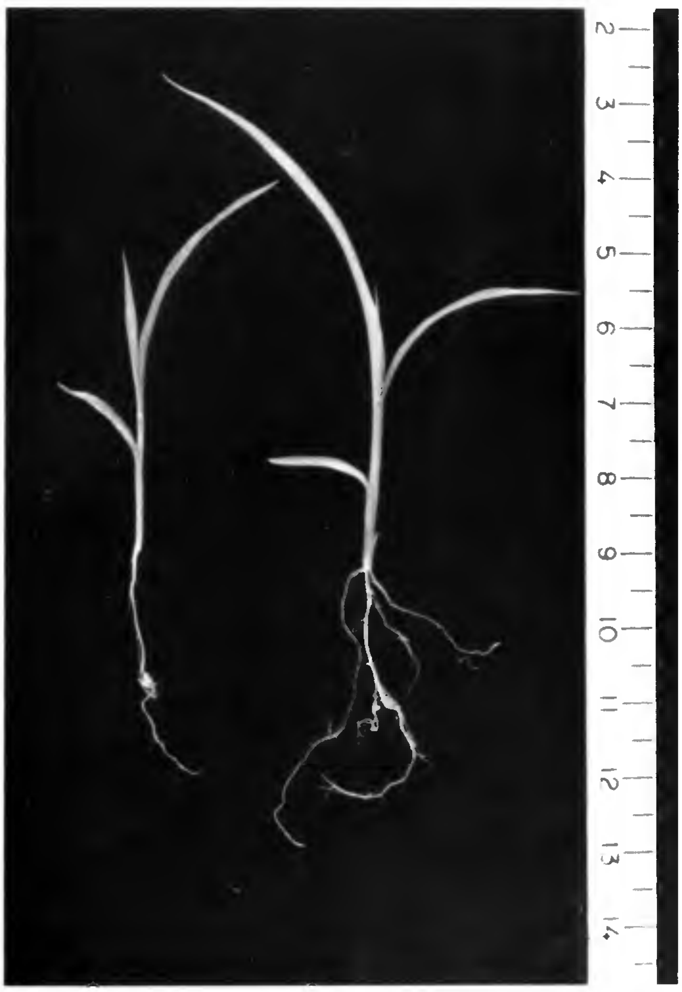

Figure 2. The Achilles' heel stage of growth for giant foxtail (left). At this stage the seedling depends on the thin threadlike mesocotyl between the seed and the crown for support. The mesocotyl can be easily broken at this stage by disturbing the soil with a rotary hoe. After the crown roots form (right), control is more difficult.

As a young giant foxtail seedling grows, the crown of the plant at the base of the stem becomes established near the soil surface. The fine subcrown internode or mesocotyl is found between the crown and the seed (51,75) (Figure 2). Although the mesocotyl supplies nutrients from the seed to the emerging plant, it is not sturdy enough to provide mechanical support. Within 1 or 2 weeks after emergence, roots appear from the crown of the plant and become established in the soil to provide mechanical support and nutrients and water from the soil (53,61).

Thus, these first few weeks are very critical in the life of the plant. Farmers wishing to control giant foxtail should consider this very vulnerable stage as the giant foxtail's Achilles' heel. If the top 1/4 to 1/2 inch of soil is disturbed before the crown roots become established, the thin threadlike mesocotyl cannot support the plant, causing it to fall over. The action of an implement such as a rotary hoe can easily break the mesocotyl, thus killing the plant. Once the crown roots become well established, however, control is much more difficult (61,63).

Giant foxtail usually begins heading in

Figure 3. A single giant foxtail seedhead can produce over 1,000 seeds.

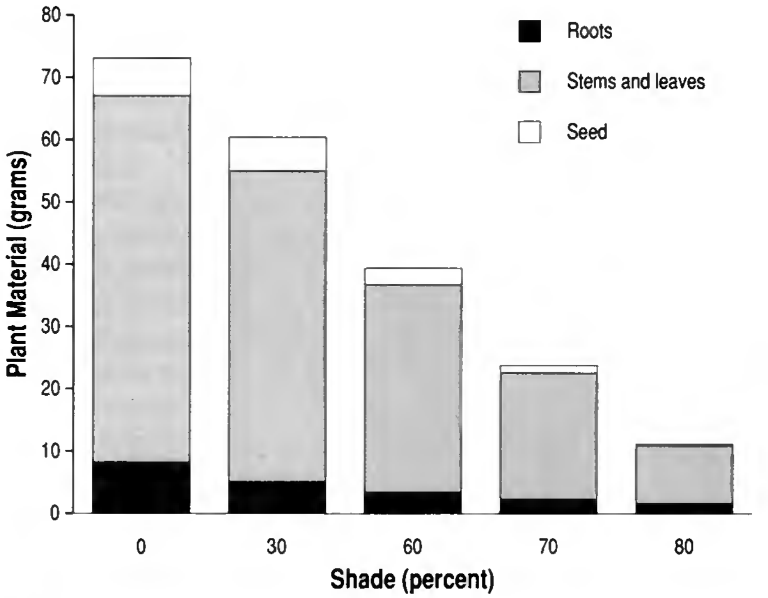

Figure 4. The effect of shade intensity on the mean per plant dry weight of seed, stems and leaves, and roots of giant foxtail.

Source: Knake, E.L. 1972. Effect of shade on giant foxtail. Weed Sci. 20:588.

late June to mid-July. Flowering starts near the tip of the panicle 4 to 5 days after it emerges. The base of the panicle flowers last. Although there has been controversy about classification of giant foxtail as a short-day plant, short days do tend to favor flowering. Under short-day greenhouse conditions, viable seed have been produced 3 weeks after emergence (45,51,106,107).

Some observers consider the head of giant foxtail to be a spike, but it is technically classified as a restricted panicle. Fully developed, mature heads may be 5 to 7 inches long. It is common to have 500 to 1,000 seeds per head, and as many as 1,400 seeds per head have been counted (Figure 3) (54,58). A plant that has been clipped earlier or has started growing late in the season may produce relatively few seeds on a single head.

Giant foxtail starts tillering a few weeks after emergence. A large plant may produce 20 to 30 basal tillers. In addition, the nodes of the main culm and basal tillers may produce 10 to 20 stem tillers (54).

In a study at Urbana, Illinois, vigorous plants growing in full sunlight each averaged nearly four new leaves per day from mid-June to late July. At maturity, plants averaged 188 leaves per plant (54).

Although shading can decrease the rate of growth of giant foxtail (Figure 4), more than 95 percent shade is required for all growth to cease (54,98). This high degree of shading is attainable under the canopy of a crop such as soybeans or corn. Relatively high populations of about 23,000 or more corn plants per acre can provide 97 percent shade or more (Table 1) (54).

The use of directed spray application of herbicides for control of giant foxtail in corn has sometimes been proposed. In order for herbicides with only moderate selectivity to effectively control giant foxtail while minimizing corn injury, a height differential between giant foxtail and corn is desirable (Figure 5). However, an appropriate height differential may occur for only a short period, necessitating a very timely application. For example, if the herbicide directions specify application of the treatment only after corn is 15 inches tall and giant foxtail is less than 8 inches tall, this height difference may exist for only a few days (61).

Table 1. Mean Percent Shade Provided by Various Corn Plant Populations

Population	Shade
plants per acre	*percent*
22,800	97.3
18,600	96.2
17,100	95.9
15,200	95.8
13,400	92.4

Source: Knake, E.L. 1972. Effect of shade on giant foxtail. Weed Sci. 20:588.

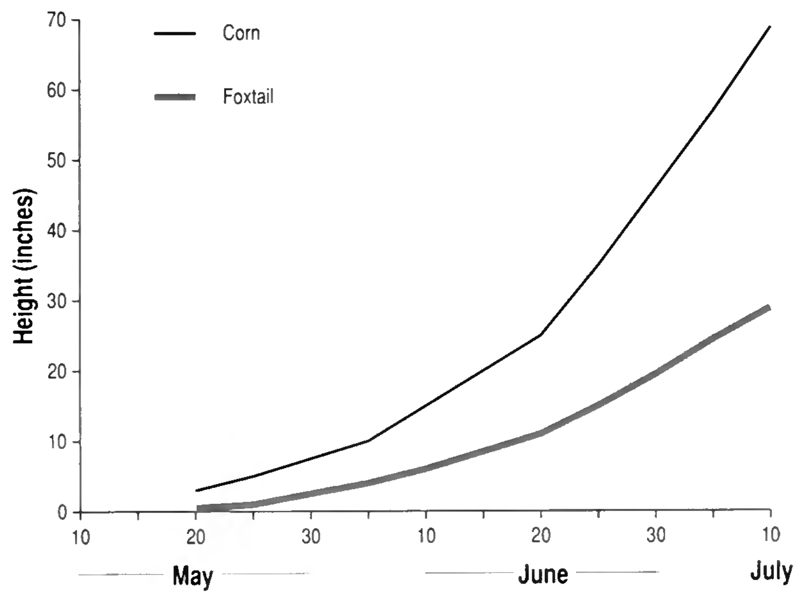

Figure 5. The growth rate and height differential for corn and giant foxtail based on the three-year mean of observations during 1963, 1964, and 1965 in 20 fields each year in Champaign County, Illinois.

Source: Knake, E.L., and F.W. Slife. 1967. Height differential of corn and giant foxtail in relation to postemergence weed control. Weeds 15:24.

Identification of Giant Foxtail

Giant foxtail is an annual grass with erect stems. The stems and leaf sheaths are hairless except for a fringe of white hairs along the margins of the leaf sheaths. Stiff hairs about 2 mm long compose the ligule. The leaf blades are 1 to 2 cm wide, 15 to 30 cm long, and pubescent on the upper surface. The spikelike, densely flowered panicles, 10 to 15 cm long, droop to form an arch. The mature plant is 4 to 5 feet tall, with some reaching 6 to 8 feet (94).

Although the vestiture or covering of the leaf surface is considered important in identification of giant foxtail, the terminology used has varied. Herrmann (46) mentions the scabrous condition of the upper surface of the leaf of the plant collected by Faber, and Rominger (94) indicates that both upper and lower surfaces are scabrous. These very short, harsh projections to give the scabrous condition might be distinguished more easily by feel than with the naked eye.

In addition to the scabrous condition, very fine, relatively straight hairs about 0.5 to 1.0 mm long are commonly found on the upper leaf surface (Figure 6). Although translation of Herrmann's Latin description (46) does not appear to mention this fine pubescence, Rominger does include it in the description he based primarily on plants collected in the United States.

Various terms are used to describe pubescence, and the terminology is often not very precise. Considering Lawrence's definitions

Figure 6. The very fine hairs (pubescence) on the upper leaf surface of giant foxtail are a major identifying characteristic.

(68) and the key he presents from Wiegand, we would tend to agree with Schreiber's use of "pilose" (103). However, "villous," "velutinous," or "puberulous" may also be possibilities, depending on how one interprets length, density, and erectness of the hairs.

In contrast to the pubescence on the upper leaf surface of giant foxtail, yellow foxtail has only a few long hairs at the base of the leaf; green foxtail has none. The pubescence of giant foxtail may be readily observed by bending a leaf over to expose the upper leaf surface to the gleam of the sun (Figure 6) (32).

Other plants that have some similarity to giant foxtail have been observed in the Midwest. Schreiber (103) has helped to clarify the distinction. In addition to *Setaria viridis* var. major (Gaud.) (giant green foxtail), Schreiber has described *Setaria viridis* var. robusta purpurea Schreiber (robust purple foxtail) and *Setaria viridis* var. robusta-alba Schreiber (robust white foxtail). While these three plants may be of similar size to giant foxtail, the drooping head of giant foxtail is a major distinguishing characteristic.

Schreiber (102) reports that the giant green, robust purple, and robust white foxtails do not have the degree of seed dormancy that giant foxtail does. He noted that these other species do not seem to compete well with giant foxtail and are not as persistent. However, Oliver and Schreiber (79) note that these other three species were not as susceptible to some herbicides as was giant foxtail.

Another species of Setaria found occasionally is *Setaria verticillata* (L.) Beauv. (bristly foxtail). This species is rather unique, with the retrorsely barbed bristles of the head causing it to attach to clothing rather easily.

Seed Production, Viability, and Longevity

With more than 1,000 seeds on some heads and more than 20 heads on some plants, giant foxtail is a prolific seed producer (54). Heltsley (45) explored the possibility of producing giant foxtail as a crop in Illinois. Although the seed contains about 22 percent protein and has been experimentally fed to chickens, it shatters readily at maturity. One test yield averaged only 350 pounds of seed per acre (45).

Seed counts have indicated 554 giant foxtail seeds per gram or 251,516 seeds per pound (53). Weight of 1,000 seeds is reported as 1.8 (53) to 1.9 grams (113).

New heads form over a relatively long period and can be observed in various stages of maturity at one time. Some heads may produce immature seed (51,54). One test by King (51) indicated that 20 percent of the seeds were imperfect or unfilled. For some seed lots, germination was in the range of 35 to 60 percent. Such factors as temperature, moisture, light or dark, and inhibitory substances may affect germination. Work by King (51) and by Heltsley (45) indicate that seed exposure to outdoor winter conditions or alternate warm and cold temperatures enhance germination. A study by King (51) indicated 10 percent better germination in light than in dark.

Observations by King (51) and our own observations suggest that germinating seed on moist filter paper produces one or more substances that inhibit germination of other seeds of the same species. The presence of soil or charcoal, however, appears to absorb the inhibiting substances and negate their allelopathic effects. Alternate wetting and drying of the soil has been suggested as a possible way to remove inhibitory substances. The seed coat does not appear to inhibit germination, and scarification has reduced germination (51).

The seeds of a closely related species, *Setaria viridis* (green foxtail) were reported by Chepil (19) as generally not germinating in the fall of the year that they are produced. After overwintering, the seeds germinated readily the next spring. Several hundred giant foxtail seeds may germinate per square foot in the field. Heltsley (45) reported 300 to 700 seedlings per square foot. In our studies, we found an average of 410 seedlings per square foot in cultivated areas and 704 seedlings per square foot in a fencerow (53).

The results of long-term studies to indicate longevity of giant foxtail in the soil are not available as for yellow foxtail. Because the seeds appear to be quite similar, the 30-year period cited in the W.J. Beal burial studies for yellow foxtail (6) may also apply to giant foxtail. Under actual field conditions, however, many seeds in the upper soil profile either germinate or decompose within a few years. Work by Dawson and Bruns (25) with green and yellow foxtail under field conditions suggests maximum longevity of less than 15 years.

Interest in the longevity of giant foxtail is primarily academic. Because the plant is so widespread and well established, it is not likely that this weed will be eradicated soon from infested areas. Conscientious control, however, can reduce seed production, the number of seeds in the soil reservoir, and the degree of infestation in individual fields.

Competition

The herbicide 2,4-D was discovered and introduced in the 1940s primarily for the control of broadleaf weeds. The cost was quite low. In the mid- to late 1950s, a new generation of soil-applied herbicides was introduced. Some of these provided control of grass weeds such as giant foxtail; however, their cost was significantly more than the cost of 2,4-D. Thus, farmers began asking if weeds such as giant foxtail decreased yields sufficiently to justify the cost of those new herbicides at $2 to $5 per acre for a 14-inch band applied over the crop row.

It seemed reasonable to assume that degree of yield reduction would depend on intensity of the infestation. But to help answer the farmers' question, studies to determine "thresholds" were initiated at the University of Illinois Agronomy South Farm at Urbana in the late 1950s (53,59).

During the 1960s, additional competition studies were conducted at Urbana to determine the best time to control foxtail (62). The results of this research became increasingly meaningful as postemergence herbicides were introduced and offered an alternative to the earlier preemergence treatments. Studies to determine the effect of time that giant foxtail began growing would provide a basis for decisions about how long control was needed from a herbicide or how many treatments might be needed (60).

The studies indicating the effect of shade on giant foxtail would have important implications as farmers increased corn plant populations per acre, changed to narrower rows, and increased the amount of "solid-seeded" drilled soybeans. Observations made to better understand the life cycle of giant foxtail and the morphological characteristics provided additional leads for designing chemical and nonchemical control measures.

Effect of various intensities of giant foxtail. The studies of the late 1950s and 1960s, conducted at Urbana, Illinois, aided in developing a better understanding of the nature of competition or interference between weeds and crop plants (53,59,60, 62). Several studies by others have also helped in the developing and testing of concepts and theories relating to such competition or interference (27,73,77,86,108, 109,112).

Each unit area of land has a certain amount of available energy in the form of nutrients, moisture, and light for which weeds and crops compete. The farmer's primary responsibility is to convert this energy into a form useful to human beings—a form that can be conveniently stored, transported, and processed.

The total amount of energy units that can be harvested from a unit area of land appears to be relatively constant in a given situation. Crop yields are generally reduced in proportion to the amount of weeds present. A very general rule of thumb is that one pound dry weight of weeds means one pound dry weight less of crop. Figure 7 illustrates the effect of giant foxtail on the dry weight of corn, and Figure 8 illustrates the effect of giant foxtail on the dry weight of soybeans. Note that the total dry weight of crop plus weeds remained about the same as the total dry weight of crop produced without weeds present (53). Table 2 shows the effect of giant foxtail on corn and soybean yields (53). As expected, an increase in weeds means a corresponding

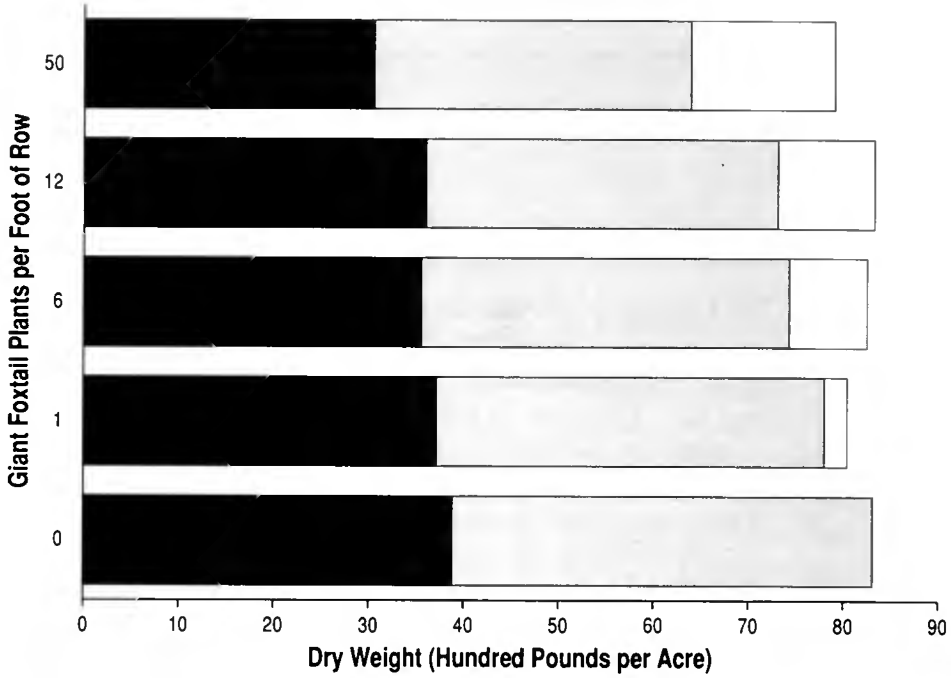

Figure 7. The effect of giant foxtail on dry matter produced by corn.
■ = stalks and cobs, □ = shelled corn, and □ = weeds.

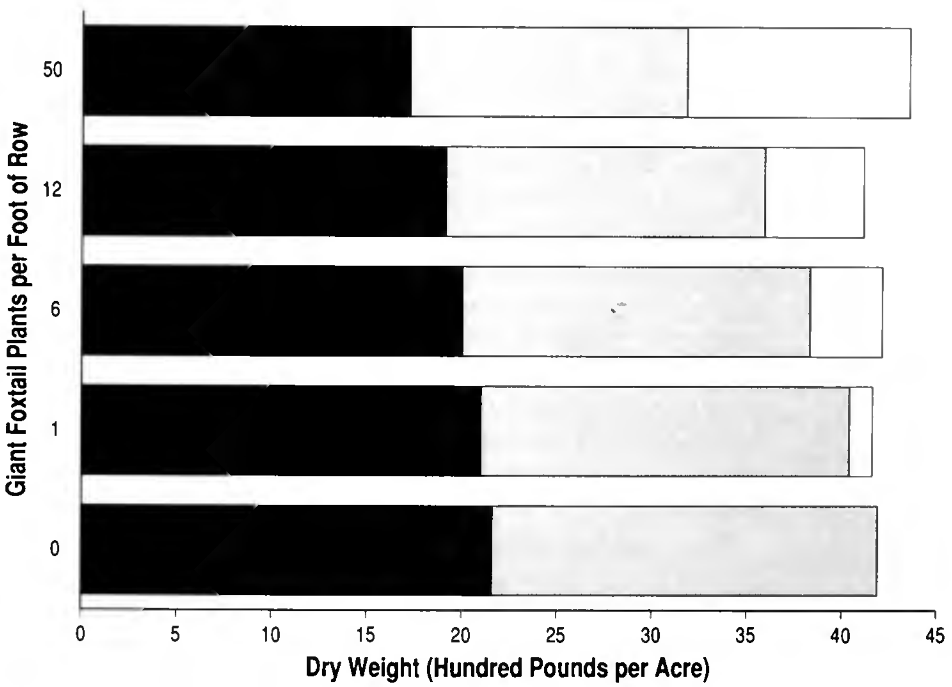

Figure 8. The effect of giant foxtail on dry matter produced by soybeans:
■ = straw, □ = beans, and □ = weeds.

Table 2. Effect of Giant Foxtail on Corn and Soybean Yields (Three-Year Means)*

Giant foxtail	Corn yield	Soybean yield
plants per foot of row	*bushels per acre*	
50	70.6[a]	27.6[a]
12	78.4[b]	31.9[b]
6	82.1[b,c]	34.6[c]
3	85.0[c,d]	36.2[d]
1	86.4[d,e]	36.8[d]
0.5**	90.4[e,f]	37.1[d,e]
Weed-free check	93.5[f]	38.5[e]

*Statistical analyses according to Duncan's multiple range test were at the 0.05 probability level. Any two means followed by the same letter do not differ significantly.

**One weed every 2 feet.

Source: Knake, E.L., and F.W. Slife. 1962. Competition of *Setaria faberii* with corn and soybeans. Weeds 10:26.

Table 3. The Percent Reduction in Corn and Soybean Yields from the Presence of Giant Foxtail (Three-Year Means)

Giant foxtail	Corn yield	Soybean yield
plants per foot of row	*percent reduction*	
50	25	28
12	16	17
6	12	10
3	9	6
1	7.5	4.5
0.5*	3	3.5

*One weed every 2 feet.

Source: Knake, E.L., and F.W. Slife. 1962. Competition of *Setaria faberii* with corn and soybeans. Weeds 10:26.

decrease in crop yield. Table 3 presents similar information as the "percent reduction" in yield.

In competition studies with soybeans (53,59), one of the main effects from competition was a reduction in the number of pods per plant and a concomitant reduction in yield. There was little or no effect on the size of the beans or the number of beans per pod (53,59).

Phytotoxic substances from one species may also inhibit the growth of another species. This is referred to as *allelopathy*. A combination of competition and allelopathic effects is termed *interference*. In the greenhouse, Bell and Koeppe have demonstrated significant allelopathic effects from giant foxtail on corn, but effects were not as evident on soybeans (8,65).

The concept of *economic thresholds*, the degree of infestation at which control becomes economically advantageous, has been used for insect infestations. The information in Table 3 could similarly be used to determine the level of weed infestation at which it is economically feasible to control the weeds. But as well as considering the direct loss from even a few weeds and the cost of their control in a given season, consideration also needs to be given to the weed seeds produced and their subsequent effects in future years.

In addition to the effect of various intensities of giant foxtail on crop yields, studies were conducted to determine the effect of time that giant foxtail starts growing and the effect of time of removal or control.

Effect of when foxtail starts growing. In studies at Urbana, Illinois, from 1961 through 1963 (60), giant foxtail was seeded in some plots at the same time as the crop. In other plots, the giant foxtail was seeded 3, 6, 9, or 12 weeks after the corn was planted. The results reported in Table 4 indicate that the soybeans soon had the competitive advantage over the giant foxtail when they were given a 3-week head start, and the giant foxtail was not able to make significant growth (Figure 9).

As reported in Table 4, the results with corn were similar. Giant foxtail exhibited more growth in corn than in soybeans (Figure 9), but the final yield of corn was not significantly affected if the corn had a 3-week or more head start.

Although weed species and geographic locations may affect the results, these data from the Midwest suggest the critical importance of control of giant foxtail during the first few weeks that the crop is becoming established. A good crop canopy of soybeans or considerable shading from corn plants can then provide the competition required to control the giant foxtail. A two-step process can be considered as a relay control strategy: (1) early control with herbicides or by mechanical means and (2) later control provided by the crop itself.

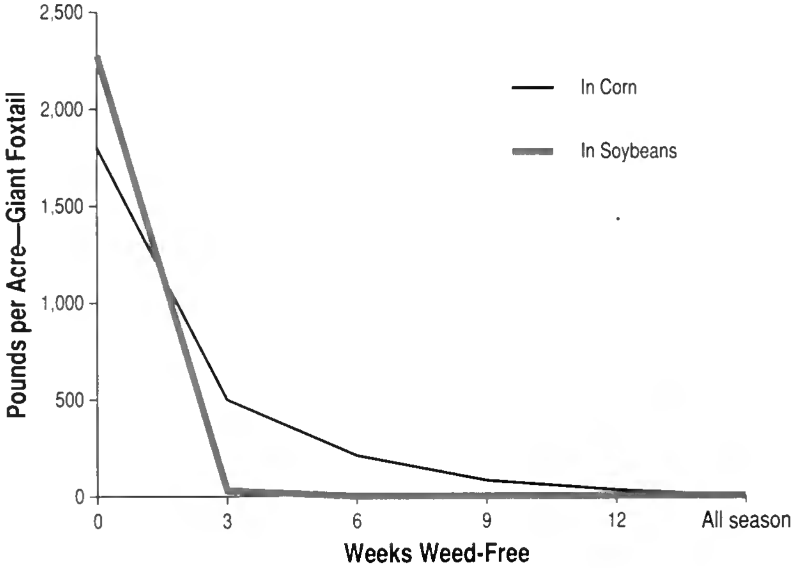

Figure 9. The pounds of dry matter per acre produced by giant foxtail as affected by the number of weeks that corn and soybeans were weed-free.
Source: Knake, E.L., and F.W. Slife. 1965. Giant foxtail seeded at various times in corn and soybeans. Weeds 13:331.

Effect of when foxtail is removed. In another study conducted at Urbana, Illinois, from 1963 through 1965 (62), giant foxtail was seeded at the same time as the crop in all plots except the weed-free check plots. The giant foxtail was then removed at approximately six-day intervals at heights of 3, 6, 9, or 12 inches. The results of these studies indicate that the giant foxtail was not sufficiently competitive with soybeans or corn to cause significant yield reduction if removed before reaching a height of about 6 to 9 inches (Table 5).

This study suggests that the competition from giant foxtail during the early vegetative growth stage of soybeans is not nearly as critical as later when soybeans are in the reproductive stage of growth—flowering, setting pods, and when beans are filling.

These studies (61-63) support the feasibility of using postemergence herbicides or other control measures early in the season to control giant foxtail in corn and soybeans. The treatment should provide good control and be adequately selective to avoid any adverse effects on the crop.

Table 4. The Effect of Time of Seeding Giant Foxtail on Corn and Soybean Yields (Three-Year Means)

Giant foxtail seeded after crop	Corn	Soybeans
	bushels per acre	
Same day	114.9*	27.9*
3 weeks	130.6	37.7
6 weeks	131.7	38.8
9 weeks	130.1	38.9
12 weeks	132.3	38.4
Weed-free check	132.2	38.3

*The yield was significantly lower than the weed-free check according to Dunnett's test for comparison of all treatment means with a control at 0.05 probability level.

Source: Knake, E.L., and F.W. Slife. 1965. Giant foxtail seeded at various times in corn and soybeans. Weeds 13:331.

Table 5. The Effect of Time of Removing Giant Foxtail on Yields of Corn and Soybeans*

Giant foxtail height when removed	Corn	Soybeans
inches	*bushels per acre*	
Weed-free check	144	30
3	143	30
6	142	30
9	139	29
12	137**	28
Foxtail left all season	126**	12**

*The means are three-year means for corn and two-year means for soybeans.

**The yields were significantly lower than the weed-free check according to Dunnett's test for comparison of all treatment means with a control at 0.05 probability level.

Source: Knake, E.L., and F.W. Slife. 1969. Effect of time of giant foxtail removal from corn and soybeans. Weed Sci. 17:281.

Control

Although giant foxtail is one of the most significant weed problems for farmers, control can be readily achieved through cultural, mechanical, and chemical methods.

Cultural Control

Noncrop areas. In noncrop areas, such as roadsides, ditchbanks, and fencerows, a desirable perennial species such as smooth bromegrass, tall fescue, or crown vetch can provide very effective and economical control of giant foxtail. Because giant foxtail simply cannot compete with such vigorous, well-established perennials, it is essentially nonexistent in these areas. Even a perennial weed such as quackgrass precludes growth of giant foxtail. The seeds of giant foxtail may still be present in such areas, however, and giant foxtail can quickly reinvade if the perennial is controlled.

Several soil sterilants and postemergence treatments such as glyphosate (Roundup) are available if needed for bare-ground areas such as parking lots, storage areas, and driveways.

Cropland. Winter wheat is also very competitive with giant foxtail and provides good control. But soon after harvest, giant foxtail can grow rapidly in small-grain stubble and produce considerable seed. Control can be achieved through tillage or by spraying with a suitable herbicide.

Spring-seeded small grain such as oats is much less competitive with giant foxtail than winter wheat. However, a good stand of oats can suppress foxtail. After the small-grain harvest, foxtail can resume prolific growth and produce considerable seed.

A good, dense stand of a forage crop such as alfalfa or clover is also quite competitive with giant foxtail once the forage is well established. Giant foxtail can, however, present a problem for new seedings and thin stands of forage crops (45,100).

In addition to the competitive effect of crops such as wheat and alfalfa, allelopathic effects may also be involved in suppressing growth of giant foxtail (65,74,84).

Mechanical Control

Mowing. Mowing of giant foxtail in small-grain stubble does not provide effective control. Clipped plants produce new growth quickly, and heads, though small, produce seed quickly (101).

Rotary hoe. The timely use of the rotary hoe (63,72,89) can provide effective control of giant foxtail in corn and soybeans. The rotary hoe can be used after seed germination, before emergence while seedlings are "in the white," or soon after emergence. It is important to use the rotary hoe before the crown roots of giant foxtail help the plant to become more firmly established.

Row cultivation. Row cultivation is effective and can provide control when giant foxtail plants are small enough to smother from soil thrown into the row. Band application of herbicides over the row makes cultivation easier, but this is not as popular as it formerly was (58).

Biological Control

Giant foxtail may not be immune to attack by insects and diseases. Thus far, however, there have been very few reports or observations of significant effect from natural enemies with the possible exception of chinch bugs.

Chemical Control

Many herbicides provide control of giant foxtail (10,57,58,63,64,89). Some herbicides can be applied and incorporated prior to planting. Other herbicides can be applied preemergence to the soil surface at planting time. Some herbicides can be applied either way. Herbicides are also available for postemergence control after the foxtail is up and growing (7,12,13,33,36,123).

For most of the soil-applied herbicides, optimum placement is in approximately the top 2 inches of the soil (57,64,88). The moisture in the shoot zone, the most critical site of uptake for some herbicides (Table 6), enhances uptake by the emerging shoot (4,22,34,39,57,64,88,114,118). Surface applications are effective if followed by adequate rainfall to provide sufficient moisture for absorption of the herbicide by the emerging weed seedlings. Incorporation of the herbicide allows less dependence on rainfall if the soil is sufficiently moist to mobilize the herbicide so it can be absorbed by the weed seedlings.

Corn. Control of giant foxtail in corn is possible with the use of thiocarbamates such as butylate (Sutan) and EPTC (Eradicane) and chloroacetamides such as alachlor (Lasso) and metolachlor (Dual). These herbicides are used in combination with other herbicides, such as atrazine and cyanazine (Bladex), which improve control of broadleaf weeds.

Table 6. The Effect of Herbicide in Shoot, Root, and Seed Zones on the Dry Weight of Giant Foxtail Tops

Herbicide	Concentration	Herbicide in			
		Root zone	Shoot zone[b]	Shoot and root zones[c]	Seed zone
	parts per million	*dry weight of tops as percent of check*			
Atrazine	6	99.4	36.6	30.8	41.9
Propachlor	3	93.7	25.8	25.2	23.3
EPTC	1.5	101.0	67.7	53.9	74.5
Trifluralin	0.5	91.5	43.0	40.6	52.1
Alachlor	1	104.4	52.7	57.1	89.0[d]
Chloramben	1.5	49.7[a]	83.4	23.7	13.0[e]

Note: A sublethal concentration was used to allow observation of additive effects should they occur. The experiment was designed as a factorial, and analyses of data were performed at the 0.05 probability level for all tests of significance.

[a]In the root zone, only chloramben caused a significant reduction in the dry weight of tops.

[b]In the shoot zone, all herbicides caused a significant reduction in the dry weight of tops.

[c]The interaction effects were not significant, indicating that effects were not synergistic but additive.

[d]Alachlor was less effective in the seed zone than in the shoot zone.

[e]Chloramben was more effective in the seed zone than in the shoot zone.

Source: Knake, E.L., and L.M. Wax. 1968. The importance of the shoot of giant foxtail for uptake of preemergence herbicides. Weeds 16:393.

For postemergence control of giant foxtail in corn, some triazines are effective if applied when giant foxtail is about 1 1/2 inches tall or less. The use of tridiphane (Tandem) with some triazines has given improved control. Certain sulfonylurea herbicides are a more recent development for postemergence control of grass weeds in corn.

Soybeans. Dinitroaniline herbicides, such as trifluralin (Treflan) and pendimethalin (Prowl), provide control of giant foxtail in soybeans. Chloroacetamides such as alachlor and metolachlor are also quite effective. A herbicide for broadleaf weed control is frequently used in conjunction with these herbicides. Chloramben (Amiben) and clomazone (Command) have provided good control of giant foxtail and some broadleaf weeds.

Several postemergence herbicides have been introduced to control grass weeds such as giant foxtail in soybeans. These herbicides include sethoxydim (Poast), fluazifop-P (Fusilade), quizalofop (Assure), and fenoxaprop (Option).

Forage crops. For establishing alfalfa and some clovers, soil-applied EPTC (Eptam) or benefin (Balan) are quite effective for control of giant foxtail. Some of the relatively new postemergence herbicides for soybeans, such as sethoxydim (Poast), fluazifop-P (Fusilade), and quizalofop (Assure), also have potential for some broadleaf forage crops if registered for this use. Poast has been registered for use in alfalfa.

Set-aside acres. Once they are well established, legumes such as alfalfa and clover compete well with giant foxtail and provide effective control. Thus, on cropland set aside from production as a result of government programs, legumes can provide good cover and effective control in short-term programs. Perennial grass or a grass-legume mixture is generally more appropriate for long-term programs; eventually, the grass will dominate. Some of the herbicides indicated for forage crops can also control giant foxtail in set-aside acres.

Noncrop areas. In some stubble fields and in noncrop areas, glyphosate (Roundup) can effectively control giant foxtail. Glyphosate is applied as a postemergence spray when giant foxtail is small. Early application at relatively low rates of the herbicide makes treatment economical. Glyphosate does not provide long-term control, and treatment may need to be repeated. But because glyphosate can kill existing giant foxtail plants and prevent regrowth and heading of the treated plants, it is usually much more effective than mowing.

Summary

Giant foxtail is the most significant annual grass weed species in Illinois and much of the Midwest. Recent reports from the People's Republic of China suggest that giant foxtail may be even more widespread and intense in the Midwest than in China where it may have originated.

Thresholds have been established to indicate the degree of corn and soybean yield reductions caused by various intensities of giant foxtail. These thresholds can be used to determine the relative economic advantage for use of various control measures in individual fields with different intensities of the weed.

Studies of the time of giant foxtail removal indicate some flexibility in timing of control measures during the first few weeks of giant foxtail growth. But control should be achieved sometime during these first few weeks to avoid yield reductions.

Studies in which giant foxtail was seeded at various times also suggest emphasis on early control in the first few weeks of growth. With adequate crop plant populations to provide shade and other competitive effects, giant foxtail that emerges in mid- to late season is not likely to make sufficient growth to significantly affect yields.

For most effective control of giant foxtail, a system should be planned to provide control on all areas of the farm—in corn, soybeans, small grain, forages, set-aside acres, fencerows, and other noncrop areas.

Chemical and nonchemical controls can be quite effective when used in a complementary manner. Effective control can be provided by using clean seed, narrow rows, and relatively high plant populations to provide shade and good competition; early rotary hoeing before crown roots form; early row cultivation so that soil can be moved into the row to smother foxtail; soil-applied herbicides; and postemergence herbicides. There is little evidence thus far of much natural control from insects or diseases for this introduced species.

Most farmers are doing a relatively good job of controlling giant foxtail in corn and soybeans. Soil-applied herbicides for control of grass weeds are currently used on nearly all corn and soybean acreage. Several postemergence herbicides are now available for effective control of grass weeds in soybeans. Additional herbicides are being introduced for selective postemergence control of grass weeds in corn.

There is a need for more emphasis on giant foxtail control in small-grain stubble, forages (particularly when establishing legumes), set-aside acres, fencerows, and other noncrop areas.

Infestations of giant foxtail can be controlled well enough to avoid yield reductions. With good control practices on all areas of a farm, the intensity of infestations can be reduced gradually. However, some seed may remain viable in the soil for many years, and there is little hope of eliminating the species completely.

References

1. Allard, H.A. 1941. Some plants found in Virginia and West Virginia. Virginia J. Sci. 2:119.

2. Anderson, R.N., R. Behrens, and A.J. Linck. 1962a. Effects of dalapon on some chemical constituents in sugar beets and yellow foxtail. Weeds 10:4.

3. Anderson, R.N., A.J. Linck, and R. Behrens. 1962b. Absorption, translocation, and fate of dalapon in sugar beets and yellow foxtail. Weeds 10:1.

4. Appleby, A.P., W.R. Furtick, and S.C. Fang. 1965. Soil placement studies with EPTC and other carbamate herbicides on *Avena sativa*. Weed Res. 5:115.

5. Ashton, F.M., and K. Dunster. 1961. The herbicidal effect of EPTC, CDEC, and CDAA on *Echinochloa crusgalli* with various depths of soil incorporation. Weeds 9:312.

6. Beal, W.J. 1941. Sixty-year period for Dr. Beal's seed viability experiment. (H.T. Darlington) Am. J. Bot. 28:271.

7. Biniak, B.M., and R.J. Aldrich. 1986. Reducing velvetleaf and giant foxtail seed production with simulated-roller herbicide applications. Weed Sci. 34:256.

8. Bell, D.T., and D.E. Koeppe. 1972. Noncompetitive effects of giant foxtail on growth of corn. Agron. J. 64:321.

9. Blackshaw, R.E., E.H. Stobbe, and A.R.W. Sturko. 1981. Effect of seeding dates and densities of green foxtail on the growth and productivity of spring wheat. Weed Sci. 29:212.

10. Blanchard, K.L., and R.S. Dunham. 1965. Comparison of various herbicides for control of giant foxtail growing in corn. NC Weed Control Conf. Res. Rept. 13:87.

11. Bloomberg, J.R., and L.M. Wax. 1978. Absorption and translocation of mefluidide by soybean, common cocklebur, and giant foxtail. Weed Sci. 26:434.

12. Boydston, R.A., and F.W. Slife. 1986. Alteration of atrazine uptake and metabolism by tridiphane in giant foxtail and corn. Weed Sci. 34:850.

13. ———. 1987. Postemergence control of giant foxtail in corn with tridiphane and triazine combinations. Weed Sci. 35:103.

14. Bubar, C.J., and I.N. Morrison. 1984. Growth responses of green and yellow foxtail to shade. Weed Sci. 32:774.

15. Buhler, D.D. and T.C. Daniel. 1988. Influence of tillage systems on giant foxtail, *Setaria faberi*, and velvetleaf, *Abutilon theophrasti*, density and control in corn, *Zea mays*. Weed Sci. 36:642.

16. Bunting, E.S., and J.W. Ludwig. 1964. Plant competition and weed control in maize. Proc. 7th British Weed Control Conf. (Brighton, England) 1:385.

17. Burnside, O.C., and G.A. Wicks. 1967. The effect of weed removal treatments on sorghum growth. Weeds 15:204.

18. Chase, A. 1948. The meek that inherit the earth. U.S. Dept. of Agric. Yearbook (Grass).

19. Chepil, W.S. 1946. Germination of weed seeds. II. The influence of tillage treatments on germination. Sci. Agr. 26:347-357.

20. Chow, P.N.P., and R.D. Dryden. 1973. Wheat tolerance to TCA for green foxtail control. Weed Sci. 21:238.

21. Clements, F.E., J.E. Weaver, and H.C. Hanson. 1929. Plant competition—an analysis of community function. Carnegie Institute. Washington, D.C.

22. Dawson, J.H. 1963. Development of barnyardgrass seedlings and their response to EPTC. Weeds 11:60.

23. ———. 1964. Competition between irrigated field beans and annual weeds. Weeds 12:206.

24. Dawson, J.H., and V.F. Bruns. 1962. Emergence of barnyardgrass, green foxtail, and yellow foxtail seedlings from various soil depths. Weeds 10:136.

25. ———. 1975. Longevity of barnyardgrass, green foxtail, and yellow foxtail seeds in soil. Weed Sci. 23:437.

26. Dawson, J.H., and E. Dell'Agostino. 1978. Control of foxtail millet (*Setaria italica*) in new seedings of alfalfa (*Medicago sativa*) with EPTC applied in subsurface lines. Weed Sci. 26:637.

27. Dunham, R.S. 1964. Losses from weeds. Univ. Minnesota Special Rept. No. 13.

28. Eberlein, C.V., and R. Behrens. 1984. Propanil selectivity for green foxtail in wheat. Weed Sci. 32:13.

29. Evers, R.A. 1949. *Setaria faberii* in Illinois. Rhodora 51:391.

30. Fairbrothers, D. K. 1959. Morphological variation of *Setaria faberii* and *Setaria viridis*. Brittonia 11:44.

31. Feltner, K.C., H.R. Hurst, and L.E. Anderson. 1969. Yellow foxtail competition in grain sorghum. Weed Sci. 17:211.

32. Fernald, M.L. 1944. *Setaria faberii* in Eastern America. Rhodora 46:57.

33. Fletchall, O.H. 1964. Control of weeds in corn with directed postemergence sprays. NC Weed Control Conf. Res. Rept. 21:120.

34. Friesen, H.A., J.D. Banting, and D.R. Walker. 1962. The effect of placement and concentration of 2,3-DCDT on the selective control of wild oats in wheat. Can. J. Plant Sci. 42:91.

35. Funderburk, H.H., Jr., and J.M. Lawrence. 1963. Absorption and translocation of radioactive herbicides in submersed and emersed aquatic weeds. Weed Res. 3:304.

36. Gentner, W.A. 1964. Herbicidal activity of several *s*-triazines as postemergence sprays. Weeds 12:115.

37. Gleason, L.S. 1956. Weed control in corn in the wet tropics. Proc. NC Weed Control Conf. 13:54.

38. Grafstrom, L.D., Jr., and J. D. Nalewaja. 1988. Uptake and translocation of fluazifop in green foxtail (*Setaria viridis*). Weed Sci. 36:153.

39. Grover, R. 1966. Influence of organic matter, texture, and available water on the toxicity of simazine in soil. Weeds 14:148.

40. Hamner, K.C. 1940. Interrelation of light and darkness in photoperiodic induction. Bot. Gaz. 101:658.

41. Harris, T.C., and R.L. Ritter. 1987. Giant green foxtail and fall panicum competition in soybeans. Weed Sci. 35:663.

42. Harrison, S.K., C.S. Williams, and L.M. Wax. 1985. Interference and control of giant foxtail in soybeans. Weed Sci. 33:203.

43. Hawton, D., and E.H. Stobbe. 1971a. The fate of nitrogen in rape, redroot pigweed, and green foxtail. Weed Sci. 19:555.

44. ———. 1971b. Selectivity of nitrogen among rape, redroot pigweed, and green foxtail. Weed Sci. 19:42.

45. Heltsley, R.G. 1953. Distinguishing characteristics, distribution, life history, and control of *Setaria faberii* Herrm. M.S. thesis, Univ. Illinois.

46. Herrmann, W. 1911. Über das phylogenetische alter das mechanischen Gewebesystems bei *Setaria*. Beitr. Biol. Pflanzen 10:1-69.

47. Hitchcock, A.S. 1950. Manual of Grasses of the United States (2nd ed.). USDA Misc. Publ. 200.

48. Jones, G.N., and G.D. Fuller. 1955. Vascular Plants of Illinois. Urbana: Univ. Illinois Press.

49. Kenny, R., J.R. Hansen, and J.F. Freeman. 1952. Giant foxtail. Univ. Kentucky Agric. Ext. Leaflet 132:1.

50. Kern, A.D., W.F. Meggitt, and D. Penner. 1975. Uptake, movement, and metabolism of cyanazine in fall panicum, green foxtail, and corn. Weed Sci. 23:277.

51. King, L.J. 1952. Germination and chemical control of giant foxtail grass. Contrib. Boyce Thompson Inst. 16:469.

52. Kishimoto, E. 1938. Chromosomenzahlen in den Gattungen *Panicum* und *Setaria*. Cytologia 9:23.

53. Knake, E.L. 1960. The effects of competition from various intensities of *Setaria faberii* Herrm. growing with corn and soybeans. Ph.D. thesis, Univ. Illinois.

54. ———. 1972. Effect of shade on giant foxtail. Weed Sci. 20:588.

55. ———. 1977. Giant foxtail. The most serious annual grass weed in the Midwest. Weeds Today 9(1):19.

56. ———. 1987. Foxtail—of questionable parentage. Crops and Soils 39:7.

57. Knake, E.L., A.P. Appleby, and W.R. Furtick. 1967. Soil incorporation and site of uptake of preemergence herbicides. Weeds 15:228.

58. Knake, E.L., and F.W. Slife. 1961. Controlling giant foxtail in Illinois. Circular 828, Univ. Illinois College of Agric., Urbana.

59. ———. 1962. Competition of *Setaria faberii* with corn and soybeans. Weeds 10:26.

60. ———. 1965. Giant foxtail seeded at various times in corn and soybeans. Weeds 13:331.

61. ———. 1967. Height differential of corn and giant foxtail in relation to postemergence weed control. Weeds 15:24.

62. ———. 1969. Effect of time of giant foxtail removal from corn and soybeans. Weed Sci. 17:281.

63. Knake, E.L., F.W. Slife, and R.D. Seif. 1965. The effect of rotary hoeing on performance of preemergence herbicides. Weeds 13:72.

64. Knake, E.L., and L.M. Wax. 1968. The importance of the shoot of giant foxtail for uptake of preemergence herbicides. Weeds 16:393.

65. Koeppe, D.E., and D.T. Bell. 1973. Chemical warfare between weeds and corn. Weeds Today 4(2):16.

66. Kollman, G.E., and D.W. Staniforth. 1972. Hormonal aspects of seed dormancy on yellow foxtail. Weed Sci. 20:472.

67. Kurtz, T., S.W. Melsted, and R.H. Bray. 1952. The importance of nitrogen and water in reducing competition between intercrops and corn. Agron. J. 44:13.

68. Lawrence, G.H. 1955. An Introduction to Plant Taxonomy. The Macmillan Company, New York.

69. Lehle, F.R., D.W. Staniforth, and C.R. Stewart. 1983. Lipid mobilization in dormant and nondormant caryopses of yellow foxtail (*Setaria Lutescens*). Weed Sci. 31:28.

70. Li, C.H., W.K. Pao, and H.W. Li. 1942. Interspecific crosses in *Setaria*. II. Cytological studies of interspecific hybrids involving (1) *S. faberii* and *S. italica*, and (2) a three-way cross, F_2 of *S. italica* × *S. viridis* and *S. faberii*. J. Hered. 33:351.

71. Lindquist, D.A., J. Hacskaylo, and J.B. Davich. 1961. Absorption and translocation of phorate and phosphorus by cotton seedlings. Bot. Gaz. 123:137.

72. Lovely, W.G., C.R. Weber, and D.W. Staniforth. 1958. Effectiveness of the rotary hoe for weed control in soybeans. Agron. J. 50:621.

73. Moolani, M.K., E.L. Knake, and F.W. Slife. 1964. Competition of smooth pigweed with corn and soybeans. Weeds 12:126.

74. Morré, J.D., and O.H. Fletchall. 1963. Germination-regulating mechanisms of giant foxtail (*Setaria faberii*). Missouri Agric. Exp. Sta. Res. Bull. 829.

75. Murray, J.S., M.M. Schreiber, and A.T. Guard. 1967. Anatomy of the first internode of giant foxtail. Weeds 15:347.

76. Nadeau, L.B., and I.N. Morrison. 1986. Influence of soil moisture on shoot and root growth of green and yellow foxtail. Weed Sci. 34:225.

77. Nieto, J., and D.W. Staniforth. 1961. Corn-foxtail competition under various production conditions. Agron. J. 53:1.

78. Norris, R.F., and C.A. Schoner, Jr. 1980. Yellow foxtail biotype studies: Dormancy and germination. Weed Sci. 28:159.

79. Oliver, L.R., and M.M. Schreiber. 1971. Differential selectivity of herbicides on six *Setaria* taxa. Weed Sci. 19:428.

80. Orwick, P.L., and M.M. Schreiber. 1975. Differential root growth of four *Setaria* taxa. Weed Sci. 23:364.

81. ———. 1979a. Interference of redroot pigweed and robust foxtail in soybeans. Weed Sci. 27:665.

82. ———. 1979b. Analysis of nonstructural carbohydrates in redroot pigweed and robust foxtail throughout the growing season. Weed Sci. 27:374.

83. Orwick, P.L., Schreiber, M.M., and D.A. Holt. 1978. Simulation of foxtail growth. The development of SETSIM. Weed Sci. 26:691.

84. Osvald, H. 1953. On antagonism between plants. Proc. 7th Intl. Botan. Congr., Stockholm 7:167.

85. Parochetti, J.V. 1974. Yellow nutsedge, giant green foxtail, and fall panicum control in corn. Weed Sci. 22:80.

86. Pavlychenko, T.K. 1949. Plant competition and weed control. Agric. Inst. Rev. 4:142.

87. Parker, C. 1963. Factors affecting selectivity of 2,3-dichlorallyl N,N-diisopropylthiolcarbamate (diallate) against *Avena* spp. in wheat and barley. Weed Res. 3:259.

88. ———. 1966. The importance of shoot entry in the action of herbicides applied to the soil. Weeds 14:117.

89. Peters, E.J., D.L. Klingman, and R.E. Larson. 1959. Rotary hoeing in combination with herbicides and other cultivations for weed control in soybeans. Weeds 7:449.

90. Plant material introduced by the Division of Foreign Plant Introduction, Bureau of Plant Industry. Inventory Nos. 102 through 116. 1930-1933.

91. Pohl, R.W. 1951. The genus *Setaria* in Iowa. Iowa State College J. Sci. 25:501.

92. Rahman, A., and R. Ashford. 1970. Selective action of trifluralin for control of green foxtail in wheat. Weed Sci. 19:754.

93. ———. 1972. Control of green foxtail in wheat with trifluralin. Weed Sci. 20:23.

94. Rominger, J.M. 1959. Taxonomy of *Setaria* (Gramineae) in North America. Ph.D. thesis, Univ. Illinois.

95. ———. 1962. Taxonomy of *Setaria* (Gramineae) in North America. Illinois biological monograph No. 29. Univ. Illinois Press, Urbana.

96. Rudyanski, W.J., R.S. Fawcett, and R. McAllister. 1987. Effect of prior pesticide use on thiocarbamate herbicide persistence and giant foxtail control. Weed Sci. 35:68.

97. Santelmann, P.W., and J.A. Meade. 1961. Variation in morphological characteristics and dalapon susceptibility within species of *Setaria lutescens* and *S. faberii*. Weeds 9:406.

98. Santelmann, P.W., J.A. Meade, and R.A. Peters. 1963. Growth and development of yellow foxtail and giant foxtail. Weeds 11:139.

99. Schoner, C.A., R.F. Norris, and W. Chilcote. 1978. Yellow foxtail biotype studies: Growth and morphological characteristics. Weed Sci. 26:632.

100. Schreiber, M.M. 1965a. Development of giant foxtail under several temperatures and photoperiods. Weeds 13:40.

101. ———. 1965b. Effect of date of planting and stage of cutting on seed production of giant foxtail. Weeds 13:60.

102. ———. 1977. Longevity of foxtail taxa in undisturbed sites. Weed Sci. 25:66.

103. Schreiber, M.M., and L.R. Oliver. 1971. Two new varieties of *Setaria viridis*. Weed Sci. 19:424.

104. Schreiber, M.M., and P.L. Orwick. 1978. Influence of nitrogen fertility on growth of foxtail. Weed Sci. 26:547.

105. Schreiber, M.M., G.F. Warren, and P.L. Orwick. 1979. Effects of wetting agent, stage of growth, and species on the selectivity of diclofop. Weed Sci. 27:679.

106. Slife, F.W. 1954. A new *Setaria* species in Illinois. Proc. NC Weed Control Conf. 11:6.

107. Slife, F.W., and W.O. Scott. 1951. *Setaria faberii*—giant foxtail. Crops and Soils 3:22.

108. Staniforth, D.W. 1953. Levels of weed infestations as related to yield losses and control practices in corn. Proc. NC Weed Control Conf. 10:44.

109. ———. 1957. Effects of annual grass weeds on yield of corn. Agron. J. 49:551.

110. ———. 1961. Responses of corn hybrids to yellow foxtail competition. Weeds 9:132.

111. ———. 1965. Competitive effects of three foxtail species on soybeans. Weeds 13:191.

112. Staniforth, D.W., and C.R. Weber. 1956. Effects of annual weeds on the growth and yield of soybeans. Agron. J. 48:467.

113. Stevens, O.A. 1957. Weights of seeds and numbers per plant. Weeds 5:46.

114. Stickler, R.L., E.L. Knake, and T.D. Hinesly. 1969. Soil moisture and effectiveness of preemergence herbicides. Weed Sci. 17:257.

115. Taylorson, R.B. 1986. Water stress-induced germination of giant foxtail. Weed Sci. 34:871.

116. Thompson, L., Jr. 1972. Metabolism of chloro s-triazine herbicides by *Panicum* and *Setaria*. Weed Sci. 20:584.

117. Todd, B.G., and E.H. Stobbe. 1977. Selectivity of dichlofop methyl among wheat, barley, wild oat, and green foxtail. Weed Sci. 25:382.

118. Upchurch, R.P. 1957. The influence of soil-moisture content on the response of cotton to herbicides. Weeds 5:112.

119. Vanstone, D.E., and E.H. Stobbe. 1978. Root uptake, translocation, and metabolism of nitrofluorofen and oxyfluorofen by fababeans (*Vicia faba*) and green foxtail (*Setaria viridis*). Weed Sci. 26:369.

120. Vengris, J. 1963. The effect of time of seeding on growth and development of rough pigweed and yellow foxtail. Weeds 11:48.

121. Vengris, J., W.G. Colby, and M. Drake. 1955. Plant nutrient competition between weeds and corn. Agron. J. 47:213.

122. Weber, C.R., and D.W. Staniforth. 1961. Competitive relationships in variable weed and soybean stands. Agron. J. 49:440.

123. Wicks, G.A. 1964. Directed postemergence herbicide sprays on corn in 1964. NC Weed Control Conf. Res. Rept. 21:130.

124. Williams, R.D., and M.M. Schreiber. 1976. Numerical and chemotaxonomy of the green foxtail complex. Weed Sci. 24:331.

125. Wollny, E. 1881. Untersuchungen über der Einfluss des Standraumes auf die Entwicklung und die Ertage der Kulturpflanzen. J. Landw. 29:25-62, 217-255, 493.

126. Wood, C.E., Jr. 1946. *Setaria faberii* in North Carolina. Rhodora 48:391.

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This bulletin is dedicated to Professor Fred W. Slife, weed science pioneer, who was one of the first to recognize the significance of giant foxtail in the Midwest. He studied the biology and life history of giant foxtail, as well as its impact on crop production, and developed practical control measures. Professor Slife was an inspiration to others whom he also encouraged to conduct research on this species.

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