Treatments applied to barley at the fully tillered stage resulted in the highest yields. Dicamba at 0.14 kg/ha and dicamba + MCPA at 0.14 + 0.42 kg/ha reduced yield at all growth stages, though differences in 1985 were not significant. Dicamba at 0.14 kg/ha and dicamba + 2,4-D at 0.14 + 0.42 kg/ha decreased kernel weight when applied to fully tillered barley.

Seed protein content of spring wheat and barley was generally increased by auxin herbicides, with the effect most evident in treatments applied at the fully tillered and boot stages. Similar results were found in winter wheat in 1984; however, 1985 data was not consistent with this trend. Changes in amino acid composition of seed proteins may accompany altered protein synthesis in response to herbicide treatment and warrants investigation.

LIFE CYCLE AND POPULATION DYNAMICS OF YELLOW FOXTAIL IN ESTABLISHED ALFALFA

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Introduction

Yellow foxtail (*Setaria glauca* L. Beauv.) is a summer annual grass that has become an economic pest in California alfalfa (*Medicago sativa* L.). A University of California Cooperative Extension Service survey revealed that in nine central valley counties yellow foxtail is the most serious summer annual weed problem in alfalfa hay fields (1).

Previous studies have demonstrated that many of yellow foxtail's biological characteristics may contribute to its adaptation to an established alfalfa hay environment. Yellow foxtail can emerge as early as February or March (2, 5, 6, 9, 11) and can achieve rapid germination when soil temperatures reach approximately 16° C and there is adequate soil moisture (1, 3). Under favorable conditions *Setaria glauca*) is known to be a prolific seed producer, with ranges from 540 to 8,460 seeds per plant being reported (4). This seed has a two- to four-month post harvest after-ripening period (2, 3, 4, 5, 7) which allows yellow foxtail to germinate the following late winter or early spring when growing conditions are again favorable.

These studies were initiated to ascertain the seasonal field life cycle of *Setaria glauca* in established alfalfa, time of emergence and its influence on length of growth stages and population dynamics, and germination and emergence potential after seed dispersal.

Materials and Methods

Two field studies, located in second year alfalfa fields in Fresno, California, were initiated during the 1984 and 1985 growing seasons. The experimental areas had no known previous yellow foxtail infestation and were treated with low rates of hexazinone and dinoseb for winter weed control, prior to trial initiation. Laboratory germination tests were also conducted in both years whereas the field emergence trial was carried out only in 1985.

Experiment 1: Seasonal Field Life Cycle

In both field studies, alfalfa plots in a completely randomized design were overseeded with *Setaria glauca* seed on December 12, 1983, and on March 20, 1985. In the 1984 experiment, two-year-old seed, collected from a Tulare County alfalfa field was used, and one-year-old seed collected in September, 1984, from an alfalfa field in Davis, California, was used in 1985. The experimental area was overseeded with 5,382 seeds (with 54% viability) per square meter in the 1984 field study and 299 seeds (with 92% viability) per square meter in 1985. During the 1984 experiment, plots were irrigated following normal irrigation schedules, whereas in 1985, plots were irrigated more frequently to favor the germination and growth of yellow foxtail. In both field studies, plots were mowed as needed. At *Setaria*

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glauca flowering, plots were hand cut with a scythe to minimize seedhead removal.

Data taken from Experiment 1 included yellow foxtail stand counts, tiller and seedhead production, seed production (1985 only), plant senescence, initial dates of all growth stages and alfalfa stand counts. A self-recording thermograph was used to obtain daily soil surface temperatures, and air temperatures were obtained from a weather station located within 3.2 kilometers of the field study.

Experiment 2: Time of Emergence and Its Influence on Length of Growth Stages and Population Dynamics

Experimental methods used and data taken were as for Experiment 1, except that existing yellow foxtail plants present in monthly treatment plots were removed at the beginning of each month; and dates of new emergence, tillering, flowering, seed maturation and plant senescence were recorded. In the 1984 field study, Experiment 2 consisted of eight non-replicated treatments (February through September) with additional data from a natural field population located within 450 meters of the test site. The 1985 field study utilized three replications of seven treatments (March through September) in a randomized complete block design.

Experiment 3: Germination and Emergence Potential After Seed Dispersal

Setaria glauca seed, collected on July 23, 1984, and August 9, 1985, from within the experimental areas, was tested for germination in the laboratory at monthly (1984) and weekly (1985) intervals. Four replications of 50 mature seeds were placed on moistened paper in petri dishes at 22 +/- 3 C° and with a 12-hour photoperiod. Germination percentages were recorded at the end of 17 days. Seed harvested in 1984 was stored outside in Fresno, California, whereas the 1985 seed was stored at a constant temperature of 22 +/- 3° C.

A field study was established to determine if a second generation of *Setaria glauca* was possible within one season. Six 0.25 square meter plots were overseeded on August 10, 1985, with the first dispersed seed from Experiment 1 in the 1985 field study.

Data from the field studies and laboratory tests were analyzed using statistical procedures from Microcomputer Statistics (MSTAT), Michigan State University.

Results and Discussion

Experiment 1: Seasonal Field Life Cycle

Setaria glauca seedling emergence began in late February in the 1984 field study and continued until a maximum population of 219 plants per square meter was achieved in May. In 1985, seedling emergence began in mid-March and reached 118 plants per square meter in August. These emergence dates confirm results of a University of California Extension Service Survey (1) that reported that yellow foxtail emergence begins in late February to early March throughout central California.

The formation of basally arising culms, or tillers, began six to ten weeks following initial plant emergence (early May in both years tested). At the 2 to 3 tiller stage the plants prostrate nature becomes apparent. This prostrate growth allows the plant to survive the frequent mowing associated with hay production (2, 8). As reported by others (4, 5, 6), tiller and seedhead production were affected by plant density; there is, as density decreased, the number of tillers and seedheads per plants were increased (Table 1). These data indicate that light infestations of *Setaria glauca* may exert a competitive effect equal to that of heavier infestations.

Table 1. *Setaria glauca* plant density and its effect on individual plant tiller and seedhead production.

Density (plants per meter)	Tillers per plant	Seedheads per plant
143.5	2.1	1.2
113.6	3.0	0.7
74.8	4.8	1.4
44.9	5.6	4.2
9.6	6.6	5.1
observation date:	5/24/84	8/15/84

Inflorescence emergence began in late June to early July, 15 weeks after initial seedling emergence. Results of the University of California statewide survey would substantiate this time period for all of central California (1). Seed maturation and dispersal occurs three to four weeks after seedhead (panicle) appearance. This short period allows *Setaria glauca* plants to disperse seed between normal alfalfa hay cuttings. Steel, et al. (10) reported that seeds fall free from subtending awns or bristles which are then left to contaminate the hay. Furthermore, after the first seed dispersal, the plant initiates culm branching which increases the number of seedheads per plant tiller. In 1984 this was observed to begin in late August and continue until the first frost. The total mature seedhead production was 112 seedheads per square meter by August 10 in the 1984 experiment and 1,495 seedheads per square meter by November 16, 1985 (after first frost).

Senescence, or aging of the plant, was first recorded in late August to early September in both field studies. These first symptoms of senescence included purpling of the flag leaf margins and chlorosis of individual plant tillers. In 1984 no further observations could be made since the study was terminated in September. In 1985, however, the first plant death was recorded on September 22; this occurred within areas of high plant density and may have been due to competition. Most plants within the field study (91%) died shortly after the first frost in mid-November. All Setaria glauca plants within the experimental area were dead by December 28, 1985, confirming that yellow foxtail is an annual plant (10).

Experiment 2: Time of Emergence and Its Influence on Length of Growth Stages and Population Dynamics

The field life cycle of Setaria glauca varied in relation to the month of emergence (Figure 1). Plants emerging in February 1984 and March 1985 exhibited longer established periods as compared to emergence in May. Flowering was initiated during mid-June to early July for plants that emerged in February through June, demonstrating the short day response of the species. Plants that emerged in June had a short tiller growth stage and flowered within seven weeks, (10.2 to 15.2 cms. in height). Plants emerging in August produced no tillers and flowered at the 3 to 4 leaf stage (5 cms. in height). Thus Setaria glauca demonstrated the potential for all plants emerging throughout the growing season to produce mature seed.

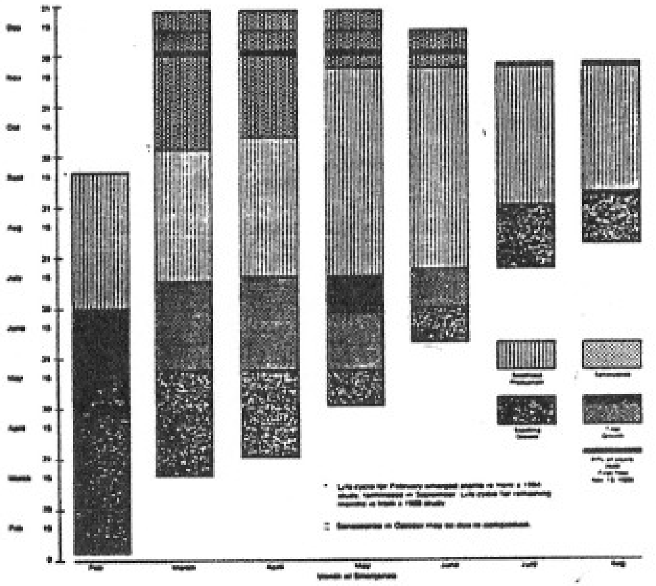

Figure 1. Growth stages of yellow foxtail in relation to month of emergence

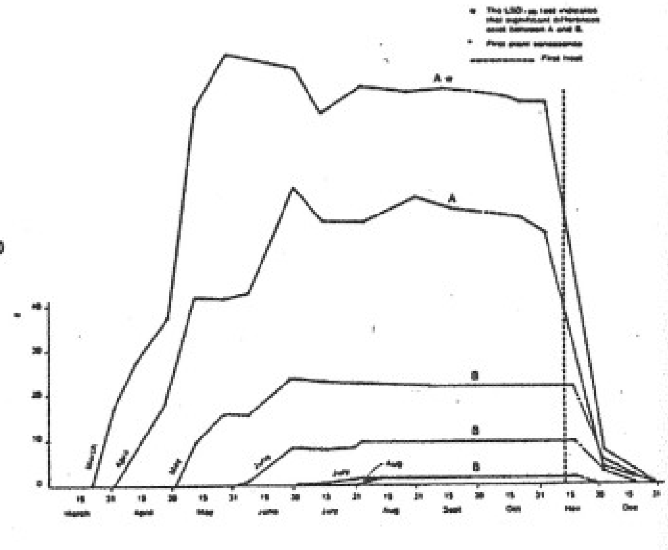

Figure 2. Setaria glauca populations in relation to month of seedling emergence

Potential yellow foxtail populations also varied in relation to month of emergence (Figure 2). Although there was no February emergence in 1985, yellow foxtail emergence was highest from February to April for the two years tested. in 1985, emergence percentages for the months of March through June were 5.7, 6.1, 5.1, and 2.7, respectively. In July and August, only 0.5% emergence was recorded in 1985, and no emergence occurred in 1984. Although not quantified, seedling emergence was observed outside the experimental area in July and August 1984. In both field studies, no seedlings emerged in September. The cumulative seasonal emergence was 3.4% of 5,382 seeds sown per square meter in the 1984 field study (2-year-old seed) and 39.6% of 299 seeds sown in 1985 (one-year-old seed).

Setaria glauca seedhead production was affected by changes in plant density and length of growth stages. Plants remaining in monthly treatment plots in 1985 demonstrated notable differences in seedhead production and ultimately viable seed production (Table 2). Results in Table 2 demonstrate that an alfalfa field with less than one seedhead per square meter has the potential to produce 43 plants per square meter the following season.

Table 2. Total Seedheads Produced and Estimated Seed Production in 1985

Month of Seedling Emergence	Actual Seedheads/M^2	Calculated Kg. of seed/ha.	Calculated Seeds/ha. (millions)
March	1,464	2,173	1,976
April	1,083	1,608	1,462
May	574	852	775
June	185	274	249
July	1.6	2.4	2.1
August	0.8	1.2	1.1

It was also observed that Setaria glauca plant density had an effect on alfalfa plant density, for when yellow foxtail plant densities increases, alfalfa stands were decreased (Table 3). In addition, alfalfa crowns in areas of high Setaria glauca plant density would resume top growth only after the death or removal of yellow foxtail plants. This may indicate that, when in competition with yellow foxtail, alfalfa plants are only suppressed.

Table 3. Setaria glauca plant density and its effect on alfalfa stands

Yellow Foxtail plants/M^2	Alfalfa plants/M^2	Total
.8	273.6	274.4
8.3	251.2	259.5
21.9	221.6	243.5
57.8	214.4	272.2
93.4	181.4	274.8

observation date: August 24, 1985

Experiment 3: Germination and Emergence Potential After Seed Dispersal

The first mature seed in both field studies was collected and tested for germination immediately and at monthly or weekly intervals. Results from the 1984 seed are shown in Figure 3. Germination potential of 1985 seed was 0% within 12 weeks and only 28% at 26 weeks after harvest. The

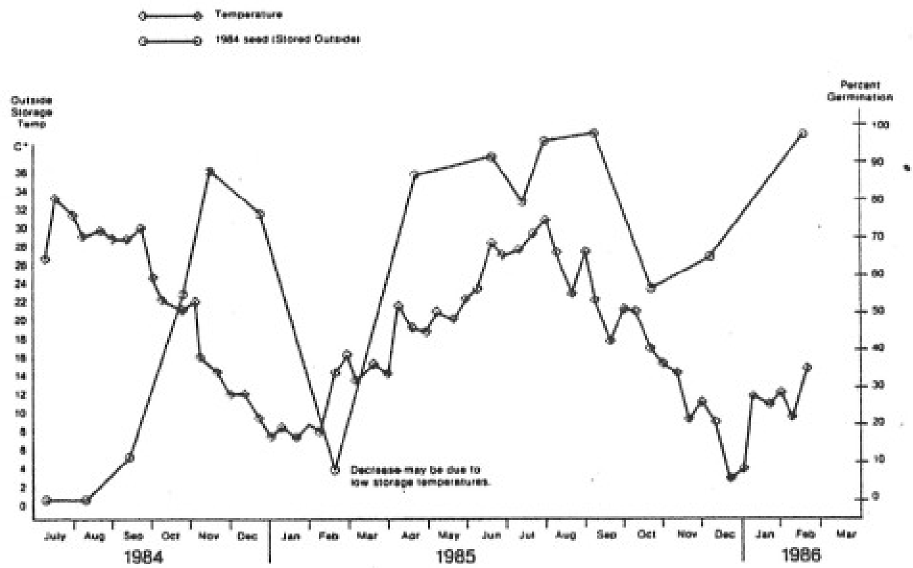

Figure 3. Germination potential of yellow foxtail seed after dispersal.

difference in the time required to complete after-ripening in these two seed lots may be due to differences in storage conditions as noted by others (10). These results show that Setaria glauca has a two- to four-month after-ripening period (3, 4, 5). The 1984 seed, which was exposed to outside fluctuating temperatures, demonstrated temperature-germination relationships (Figure 3). As storage temperatures decreased, potential yellow foxtail germination percentages were decreased.

A field emergence trial determined that a second generation of Setaria glauca was not possible within the 1985 season. Of the seed sown on alfalfa plots in August 1985, 0% emergence occurred before the first frost (15 weeks after sowing), and therefore emergence did not occur until February 1986.

The tests on the 1984 and 1985 seed lots and the field emergence trial are still in progress.

Summary

Yellow foxtail (Setaria glauca L. Beauv), a problem weed in California alfalfa, was investigated during 1984 and 1985 to determine its seasonal life cycle, a time of emergence and its influence on length of growth stages and population dynamics, and germination and emergence potential after seed dispersal. In 1984 and 1985 field studies, second year alfalfa plots were overseeded with yellow foxtail. Setaria glauca demonstrated the potential

to emerge as early as February and continue through August, with most seedlings emerging from February to April. Later emergence dates affected the length and/or presence of growth stages and decreased plant population and seedhead production. Post harvest tests indicated that seeds have a limited germination potential within two to four months after dispersal, and 1985 data indicated that yellow foxtail can have only one generation within a growing season.

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