SUMMER ANNUAL GRASSES: PROBLEMS AND CONTROL

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Weeds can be a problem during any phase of alfalfa production. In recent years summer annual grasses have become particularly troublesome. In some areas of California they have become the most serious problem in alfalfa production, accounting for loss of stand and premature ploughing out of the field after only two years, or in a few cases only one year, of production. This is the type of loss few growers can afford.

Summer annual grasses also cause losses to the grower other than reduction of stand longevity. Alfalfa yield can be substantially reduced; yield decreases of one to two tons per acre frequently occur. Hay quality is greatly reduced; the grasses involved typically have only 8% to 10% protein compared to about 22% for good alfalfa and they may be very fibrous depending on the stage of maturity. The awns--the small, rigid spikes that stick out from the flowering head (see Fig. 1)--cause another serious problem, called 'sore mouth'. When eaten by animals these awns can irritate the inside of the mouth. Harvesting grasses is tough on equipment, they do not cube well, and they can catch fire easily in a dehydrator.

In our work we have observed infestations of grass as high as 75% of the tonnage being harvested from commercial fields! The infestations can seriously affect several cuttings, typically from June or July until late October. And the problem seems to be getting worse in the last decade! We have therefore embarked on a program to try to find out why the grasses are such a problem, and to see what practices can minimize their growth, and to evaluate methods for their control.

Biology of the Grasses

What are the species of grass that are causing the problems. The two most important species are barnyardgrass (Echinochloa crusgalli (L.) Beauv.) also called watergrass, and yellow foxtail (Setaria lutescens (Weigel) Hubb.) also known locally as pigeongrass or bristle grass. Other species that occur locally only or are of much lower frequency include green foxtail (Setaria viridis (L.) Beauv.), crabgrass (Digitaria sangiunalis (L.) Scop.), sprangle top (Leptochloa spp.) and lovegrasses (Eragrostis spp.).

Barnyardgrass is probably only a problem when the alfalfa stand and vigor is weakened by some other factor. Barnyardgrass is really an opportunist, it only invades and thrives in areas where other plants are not growing. Competition studies we have been conducting showed clearly that a strong vigorous stand of alfalfa will outcompete barnyardgrass, even when the grass was seeded into the alfalfa. Any practice that weakens the alfalfa vigor will encourage barnyardgrass, and other weeds too; poor timing of irrigation and too frequent cutting are prime factors in encouraging barnyardgrass. Therefore the best control method is to grow vigorous alfalfa; herbicides can help and will be discussed later. It is worth reiterating here that no weed control practice can make up for a poor stand; perfect weed control in a weak stand still leaves you with a weak stand, plus a lot of bare soil.

Yellow foxtail, on the other hand, seems to be a much worse problem. This species has been recorded in California since the middle of the 19th century, yet it has really only become a serious problem in alfalfa in the last ten to fifteen years. We asked ourselves why, or what factors have contributed to this? Changes in cultural practices in alfalfa, particularly increased frequency of cutting, are probably one reason, but changes in the characteristics of the weed now also appear to be at least part of the reason.

Seeds of yellow foxtail were obtained from three locations in the central valley of California (from Glenn, Yolo, and Tulare counties) and from four locations in the eastern USA (Massachusetts, Connecticut, Pennsylvania and Iowa). Plants from all locations in California behaved similarly; there were some relatively small variations in the eastern biotypes but as a group they too were all similar. Differences between California and eastern biotypes were, however, very striking. All eastern biotypes grew as upright plants, but the California plants grew almost prostrate; this difference in habit is shown in Fig. 2. By measuring the growth of individual tillers a line drawing representing the

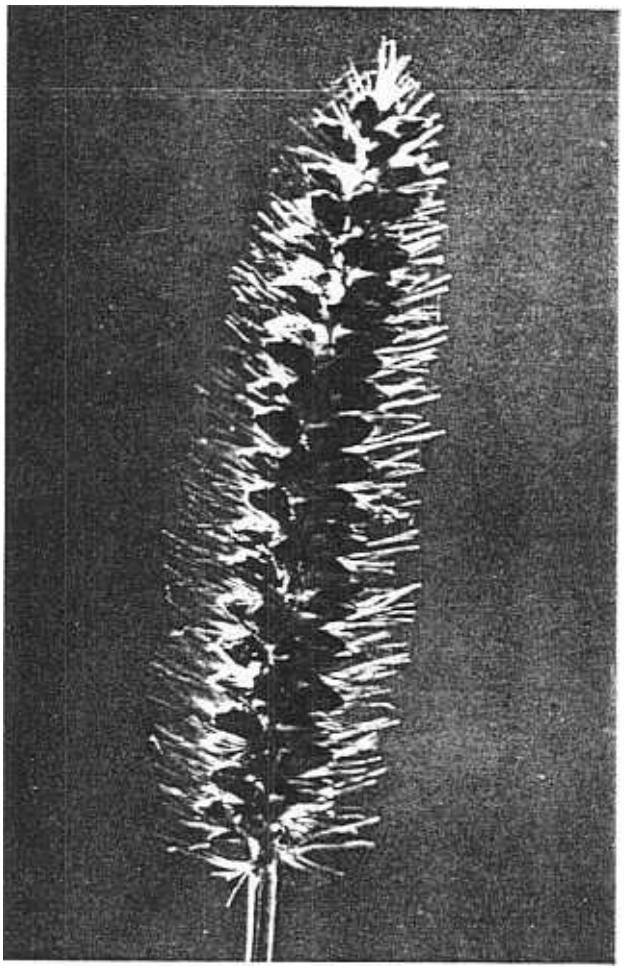

Figure 1. Close-up photograph of seed head of yellow foxtail. Note bristle-like awns projecting beyond the seeds.

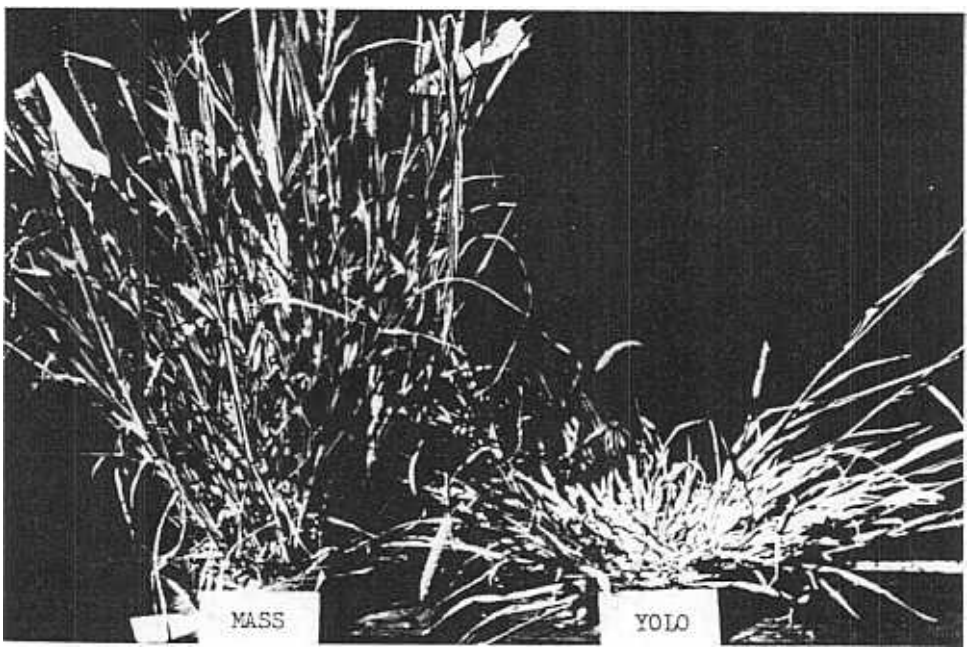

Figure 2. Comparison of the growth habit of mature yellow foxtai plants from Massachusetts (left) and Yolo county California (right).

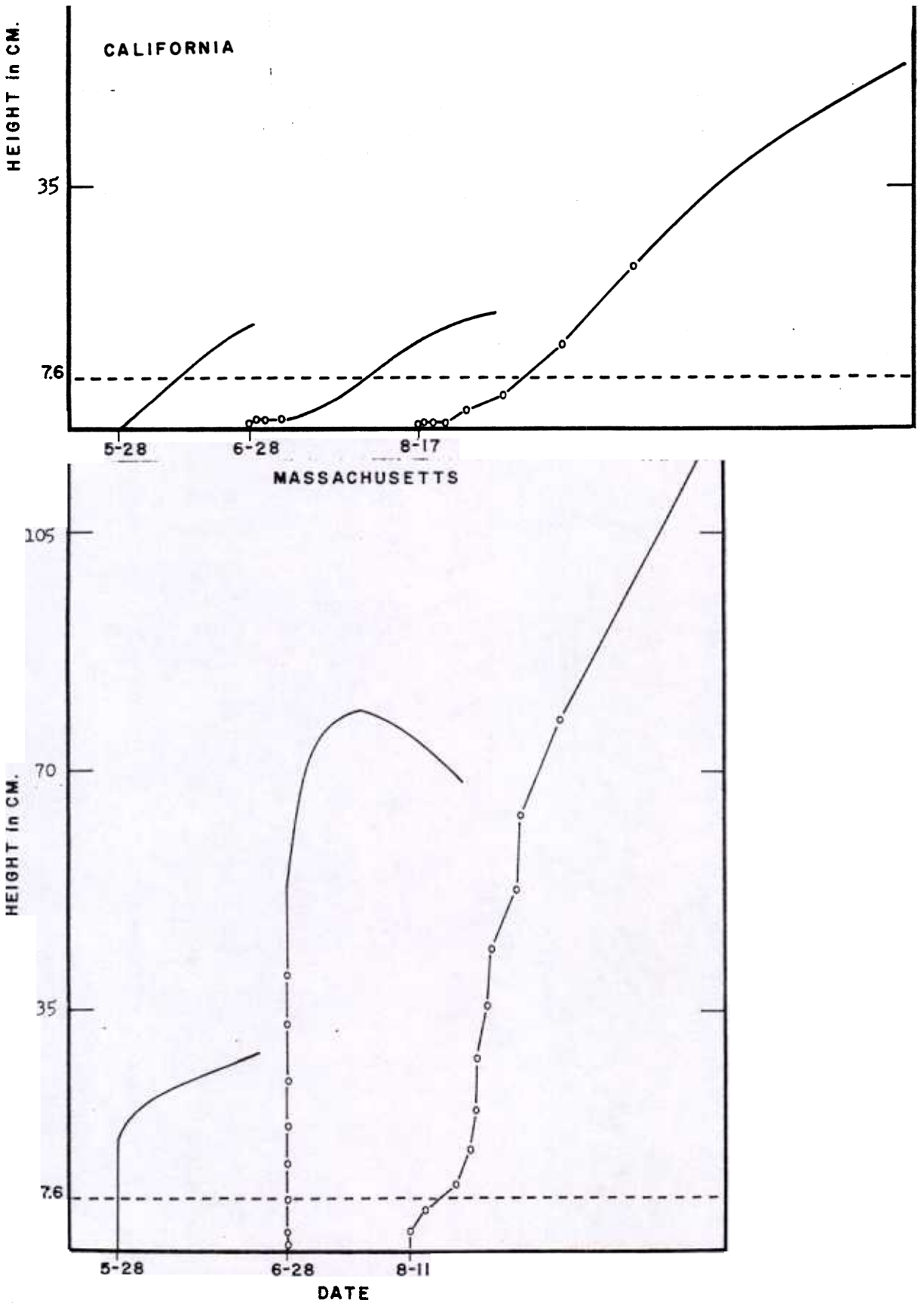

Figure 3. Diagrammatic representation of growth habit of yellow foxtail plants from Yolo county, California and from Massachusetts.

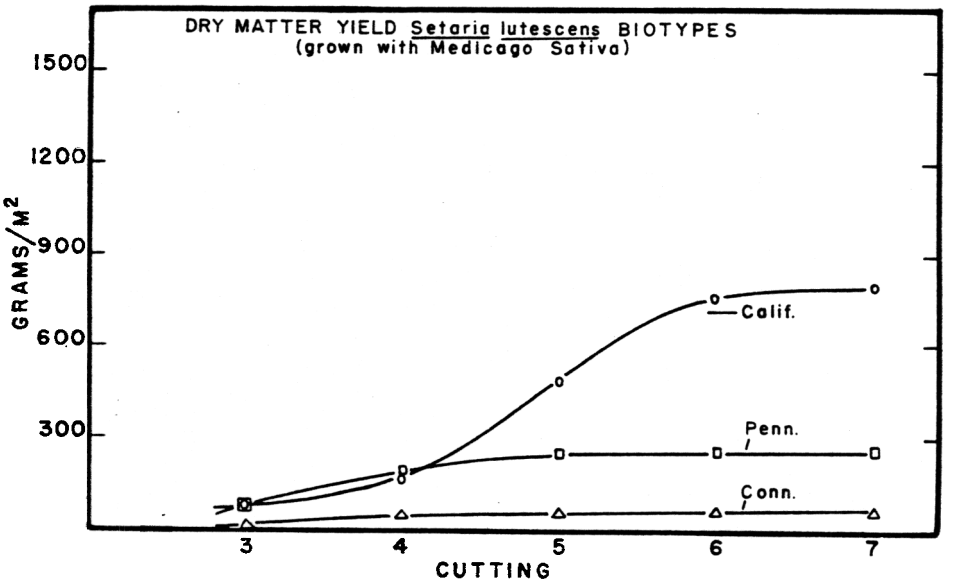

Figure 4. Cumulative yield of three biotypes of yellow foxtail grown in competition with alfalfa.

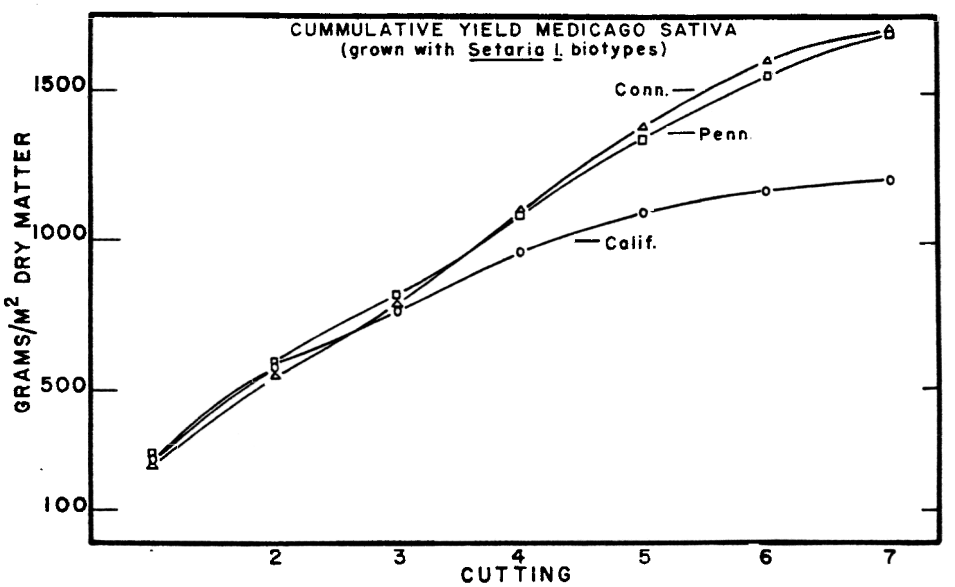

Figure 5. Cumulative yield of alfalfa grown in competition with three different biotypes of yellow foxtail.

average growth characteristics could be made (Fig. 3). These clearly showed the upright growth of eastern biotypes (Massachusetts shown) and the prostrate, almost rosette-like, appearance of the California ecotype (Yolo shown). The circles represent the position of the nodes, and the dotted line an approximation of cutter-bar height. Most of the nodes, and hence tillering and regrowth capacity, of the Massachusetts type plant would be cut off by mowing, even by June 28th. In contrast, by this date nothing except a few leaf tips would be cut off a Yolo plant, and even at Aug. 17th most of the plant would escape the cutter bar. This would seem to be an excellent adaptation for a weed growing in a crop like alfalfa in California, with its repeated mowing.

The implication of this is that the eastern biotype could not tolerate mowing, whereas mowing would not serously injure the California type. Growing the various biotypes in competition with alfalfa showed that this did occur (Fig. 4). The eastern biotypes (represented by Pennsylvania and Connecticut here) grew only slowly up to the fourth cutting, and then were essentially unable to recover and make any further growth. The California type, however, continued vigorous growth until the sixth cutting. Alfalfa yields reflected these different growth patterns of the grasses; the California type caused much greater yield reduction, especially at the fourth through seventh cuttings (Fig. 5). These, and other yield trials at U.C. Davis, confirmed that the California ecotype of yellow foxtail is extremely competitive in alfalfa.

Seed germination is an important characteristic of a weed. Yellow foxtail is usually observed as a problem in the field from June or July onwards; but it germinates much earlier. We have observed yellow foxtail to have germinated under field conditions in the central valley in March in many years. This is frequently before the first cutting. It then continues to germinate throughout the spring and summer. In studying germination characteristics we have found that the California type is much better able to germinate at higher temperatures than the eastern biotypes (Table 1, Massachusetts shown). No biotypes could germinate at 50°F or below, but by 60°F all showed fairly high levels of germination. Once soil temperatures reach about 55° to 60°F, and there is adequate moisture, then germination will occur, as observed early in the spring. The California biotype also germinated more rapidly at any given temperature than the eastern strains (Table 1); this would be a particularly useful adaptation to the irrigated situation when adequate water for germination is only available for a few days following an irrigation. Although no data are presented here, we find that the California type is less dormant than the eastern types; the latter all require chilling to promote germination but the California type did not have this requirement. This is again a useful adaptation for a weed growing in the California climate.

Table Comparison of germination characteristics of seed of California and Massachusetts ecotypes of yellow foxtail.

Cumulative germination after 17 days

Temperature	California	Massachusetts
100°F	20%	8%
90°	70	35
80°	80	65
70°	90	65
60°	70	70
50°	0	0

Time in days to achieve 50% germination

Temperature	California	Massachusetts
86°F	3.5 days	7.0 days
77°F	4.5	6.5
59°F	12.0	15.0

All factors that we have studied indicate that yellow foxtail growing in California alfalfa is a) an ecotype that differs from those in other parts of the USA that is adapted to California alfalfa production practices, especially repeated mowing, and that b) it is

strongly competitive when growing with alfalfa. Cultural practices that reduce its ability to thrive in alfalfa are essential, and effective control methods must be used, or developed.

Indirect Control

As previously mentioned, any factor that decreases the alfalfa vigor can increase the levels of grass infestation. Factors that we feel are important in determining alfalfa vigor as it relates to growth of summer annual grasses include:

a) Selection of alfalfa varieties well adapted to the local climatic and soil conditions
b) Proper land preparation
c) Disease control
d) Frequency of cutting
e) Irrigation practice
f) Insect control
g) Winter weed control

These items are not necessarily in order of importance. We will not discuss items a), b), c) or d) here, as they have been discussed at previous alfalfa symposia (Isom, 1971; Marble, 1971 and 1972).

Irrigation

We feel that the best irrigation practice, especially following the first and second cuttings, with respect to summer grass control is to make sure that there is adequate soil moisture at cutting to carry over until the alfalfa regrowth has reestablished a new canopy. We stress the importance of the first and second cuttings as these are made at the time when the grass seedlings are becoming established; by late June or July it is too late to alter the grass population. Adequate deep soil moisture at cutting keeps the shallow rooted grass seedlings dry when the canopy is open. This means that they grow slowly, or may even die from dessication; and it also means that shading from the crop is much greater when the irrigation is not made until the new alfalfa canopy closes over. Letting the field get dry before cutting and then following with irrigation before the new alfalfa canopy has had time to develope is probably the worst possible way to irrigate a grassy field. These suggestions are based on observations of fields, not on results of scientific experiments.

Weevil and winter weed control

Observations over recent years have indicated that non-residual winter treatments such as weed oil plus dinoseb ('dinitro') or flaming had reduced the quantity of grass present in the summer. In 1974 two trials were conducted that clearly demonstrated that both winter weed control and Egyptian alfalfa weevil (referred to as weevil in rest of text) control influence the incidence of summer grasses. No attempt will be made here to describe the immediate results of these experiments; suffice it to say that winter weeds, and weevils, were or were not controlled adequately at first cutting in relation to the treatments applied. Yellow foxtail germinated in late March and April, but did not start to occur in the harvested samples until the June cuttings; it was then a serious problem through the following three cuttings that we harvested (Table 2). GS-14254 (Sumitol®) was used for winter weed control as at the time these experiments were conducted we were still expecting the herbicide to be registered. We see no reason, based on our experience, to expect that diuron (Karmex®) would not provide similar results.

GS-14254 alone provided partial early control of the yellow foxtail, but the alfalfa was severely damaged by the weevils and thus provided much less competition than desirable. Weevil control without weed control also provided a substantial early suppression of grass; this could only be attributed to the competitive ability of the alfalfa in comparison to the untreated check. Combining winter weed control and weevil control provided high levels of early grass suppression, and even in late September still reduced grass by about 50%. This control was attributed mainly to the increased alfalfa vigor, which was clearly shown in the alfalfa yields, especially early in the summer. Weed oil plus dinoseb, a completely non-residual control treatment, also suppressed the yellow foxtail, but not to the same

degree as the other treatments. It was interesting to note that the alfalfa stand in trial B was rather weak in comparison with trial A; comparison of the levels of grass suppression obtained in the two trials clearly demonstrated that without the competition from the alfalfa the grass can build up much more rapidly. The june cutting results were similar in trial A and B, but by August trial B had much more grass than trial A. These data documented very dramatically how yellow foxtail can reduce alfalfa yield; at the August cutting the check in trial A had less than half the alfalfa yield of the best treatment, and in trial B it was slightly less than half; in both cases the yellow foxtail was causing a 50% reduction in yield of alfalfa. The hypothetical economics of these treatments are staggering; on a basis of $60.00 per ton, with no allowance for quality, the GS-14254 plus carbofuran treatment would have netted $80 over the four cuttings discussed. If allowance were made for quality differences this figure would increase to about $100 net. This is in addition to any benefits derived in earlier cuttings.

Table 2. Influence of winter weed control, and Egyptian alfalfa weevi control on growth of alfalfa and grasses during the following summer.

Trial A -- good stand	Alfalfa yield--tons/A					Weed yield--tons/A				
	6/3	7/5	8/12	9/13	Total	6/3	7/5	8/12	9/13	Total
GS-14254	1.28	0.86	1.23	0.51	3.88	0.05	0.11	0.18	0.51	0.85
Carbofuran	1.59	0.92	1.12	0.49	4.12	0.07	0.10	0.16	0.69	1.02
GS-14254 + Carbofuran	1.59	1.09	1.73	0.57	4.98	0.00	0.03	0.08	0.38	0.49
Weed oil + dinoseb	1.11	0.78	0.93	0.38	3.20	0.10	0.18	0.18	0.73	1.19
Untreated check	0.87	0.56	0.72	0.35	2.50	0.17	0.30	0.24	0.75	1.46
Trial B -- weak stand	**Alfalfa yield--tons/A**					**Weed yield--tons/A**				
	6/7	7/16	8/14	9/20	Total	6/7	7/16	8/14	9/20	Total
GS-14254	0.79	0.83	0.55	0.39	2.56	0.04	0.14	0.61	0.61	1.40
Carbofuran	1.04	1.04	0.51	0.44	3.03	0.10	0.13	0.54	0.66	1.43
GS-14254 + Carbofuran	1.13	1.10	0.69	0.49	3.41	0.02	0.05	0.24	0.42	0.73
Weed oil + dinoseb	0.88	0.84	0.48	0.40	2.60	0.07	0.24	0.59	0.65	1.55
Untreated check	0.58	0.72	0.35	0.29	2.04	0.28	0.32	0.75	0.83	2.18

GS-14254 applied at 2.0 lb/A on Jan. 24, 1974
Weed oil + dinoseb at 40 gal/A + 1.25 lb/A plus 40 gal/A water, applied Jan. 24, 1974.
Carbofuran at 0.5 lb/A applied on March 20, 1974.

These data indicate several points. Summer annual grass can cause tremendous loss in alfalfa yield, and substantially reduce quality. Perhaps of even greater significance is the fact that lack of weevil control caused a much earlier invasion of grass, and a more severe problem throughout the summer. The data presented here again echo earlier reports (Norris 1971, 72) in which integration of weevil and weed control programs was urged for best possible results.

Direct Control

There are two herbicides registered for use in alfalfa that can give direct control of summer annual grasses; these are trifluralin (Treflan®) and EPTC (Eptam®). It must again be emphasized that these herbicides will only provide their best possible results if there is a good vigorous stand of alfalfa to offer competition against any weeds not controlled.

Trifluralin is a chemical that must be applied preemergence to the weeds, it has no postemergence activity. It also must be incorporated into the soil; this is a problem in an established alfalfa stand. When used correctly, and good incorporation is achieved, this chemical is capable of providing in excess of 95% control for the whole growing season Difficulty of mechanical incorporation has reduced acceptance of this herbicide. Equipment such as ground driven rolling cultivators, set flat, has worked well for incorporation (e.g. Lilliston Rolling Cultivator®); satisfactory results have also been obtained following incorporation with a spring shank type harrow (e.g. Glencoe). Lack of mechanical

incorporation will mean essentially no weed control. The damage done to the alfalfa crowns by the equipment, damage to the equipment due to compacted soil conditions, and difficulty of getting equipment into the fields have led to little use of this herbicide in alfalfa.

EPTC can be applied in the irrigation water and can give good control of summer grasses Table 3 shows the type of control we have obtained, expressed as per cent control based on actual counts of grass plants, following two applications of 3.0 lb/A each of EPTC after the first cutting and again 3 irrigations later. This was in a heavily infested commercial alfalfa field at Davis. The control was actually slightly higher than indicated as the counts were made in September and newly germinating seedlings were included in the count; they would never reach large enough size to compete with the alfalfa before the end of the season. Control definitely decreased towards the lower end of the checks; we have observed this before but can only speculate concerning the reasons at present. A small plot trial currently being conducted at Davis to better determine timing of EPTC application, and potential rate sequences has clearly shown the superiority of split applications over a single larger dose (Table 4). The results in the latter trial are lower than anticipated, but we feel the results of these two trials are indicative of the levels of control attainable.

Table 3. Yellow foxtail control by water-run EPTC

	50' from inlet	middle of check	50' from lower end of check
EPTC 3.0 + 3.0	89% control	83% control	56% control

Number of grass plants counted on Aug. 28, 1975.

Table 4. Influence of water-run EPTC on yellow foxtail in alfalfa at UCD

Treatment	Yellow foxtail No/0.5 sq.m.	% control
EPTC 3.0	20	56
EPTC 6.0	20	56
EPTC 3.0 + 3.0	16	66
Untreated check	45	0

Based on grass counts made on Sept. 30, 1975.

There are several considerations that must be made if EPTC is to work well. These include:

a) The grasses must not have germinated; EPTC has very little ability to control emerged weeds. Consider this in reference to when yellow foxtail actually germinates in your area.

b) Repeat application is essential for season-long control; EPTC lasts in the soi only about 6 weeks under average growing conditions.

c) In making the repeat application make sure it is soon enough after the previous treatment that no germination has occurred. Delaying the repeat application frequently is a cause of inadequate control.

d) Water distribution along, and within, the check must be as even as possible; variations in water pattern means variations in the quantity of EPTC, which then means variations in results. Critical land leveling before planting is the best way of making sure water applied EPTC is spread evenly.

e) Keep the alfalfa vigor as high as possible; a strong vigorous stand helps the herbicide do its work.

f) Accurate calibration of the herbicide injection equipment is essential; if it runs out too early the bottom end of the field may not get enough herbicide, and if it runs too long treated water may pond at the end of the runs or run off the field.

Check the EPTC label for quantities to be used; dates of the application will vary with region in the state.

Summary

A new ecotype of yellow foxtail has developed that is adapted to the cultural practices used in California alfalfa. We attribute the increase in yellow foxtail in alfalfa in recent years to the increasing occurrence of this ecotype. Maintenance of a healthy, vigorous stand of alfalfa is still the best way to reduce the yellow foxtail problem. Winter weed control, and Egyptian alfalfa weevil control are both essential if the alfalfa is to compete successfully with the yellow foxtail. Trifluralin, incorporated preemergence, and EPTC applied as water-run in the early spring and summer, have provided satisfactory control of yellow foxtail when used properly.

Acknowledgements

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