

information gained from these studies will result in better understanding of the formation and functions of the rhizomorphs so that methods of control may be developed which will interfere with their development and functioning.

Other current work is directed toward understanding the effect of environment upon the growth and development of the fungus, with particular reference to rhizomorph production. These studies have shown that the fungus is extremely variable in its growth characteristics on culture media and that this variation is inherited (see photo). Studies have also shown that different isolates of the fungus vary in the severity of their attacks upon a given type of plant. In connection with these studies, greenhouse inoculation techniques have been improved so that considerably less time is needed to infect plants. In addition, laboratory studies have shown that there are naturally occurring substances in some woody plants which greatly stimulate rhizomorph production (see photo). One of the objectives is to isolate and identify these stimulatory substances. The effects of temperature, light, and varying levels of oxygen and carbon dioxide upon the growth of the fungus are also being studied. It has been found that *Armillaria* is inhibited by light—particularly by the shorter, or blue, wavelengths. It also has been shown that the fungus grows well at reduced levels of oxygen and at very high levels of carbon dioxide. These characteristics help to explain its survival in roots considerably below the surface of the soil. The environmental factors influencing the production of the fruiting bodies (mushrooms) of the fungus are also being investigated; though fruiting bodies have been produced under laboratory conditions, as yet not all factors involved in fruiting have been determined.

Research on control of this important fungus and the disease it causes has been and is being approached from three directions: control through resistance; control by the use of chemical fumigation; and biological control. Although the fungus occurs worldwide throughout the temperate zones, much of our knowledge of how the fungus grows and how it is controlled has been developed at the University of California.

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Pre-emergence herbicides offer the advantage of reducing early competition in seedling alfalfa stands. The disadvantages of present pre-emergence herbicides is that they have to be incorporated, which adds extra expense, and they do not control all of the broad-leaved weeds. Benfin shows promise as a pre-emergence herbicide due to good selectivity in alfalfa and full-season grass control. Post-emergence herbicides have the advantage that treatment is not necessary until the problem exists. The dinitros and 2,4-DB (ester) will control weeds if they are small. Bromoxynil (not presently registered for use on alfalfa) kills a larger number of weeds and larger weeds than the other post-emergence herbicides. With the use of post-emergence herbicides, timing the application when the weeds are small and when most of them have emerged is essential. This report results from three years of trials using pre- and post-emergence applications of various herbicides. This information does not constitute a weed control recommendation by the University of California. For current weed control recommendations, local farm advisors should be consulted.

**W**EEDS ARE A MAJOR PROBLEM in the establishment of a new stand of alfalfa. In seedling alfalfa a severe weed problem can completely crowd out the stand. When the weeds are this abundant the young plants cannot compete for soil nutrients, sunlight, and moisture. If the weeds are less abundant, they may not crowd out the stand, but they weaken the young plants and retard growth, which delays the first cutting. The quality of hay is greatly reduced when weeds are present, resulting in a lower selling price.

Many herbicides have been tested in alfalfa field trials in recent years. Some of these show a high degree of selectivity, producing clean, weed-free alfalfa that sells for as much as \$15 per ton more than weed-contaminated alfalfa.

### Pre-emergent herbicides

In 1963 a large-scale field trial was established with EPTC (Eptam) to compare methods of application (granules versus liquid dripped in irrigation water), rates, and effectiveness for weed control. Because of the size of the plots (25' by 1200'), there was only one replication of each treatment. Material was applied with equipment commonly available to alfalfa growers.

Treatments were all applied at planting time. The EPTC granules were incorporated with a disk and harrow. EPTC-6E was dripped in the irrigation water after seed was sown and worked into the soil.

All rates of granular EPTC gave good weed control. There were damage symptoms and some temporary stunting of the

EPTC treatments	Weeds (in 4 sq ft)	Alfalfa plants (per sq ft)
Check (not irrigated)	13	33
EPTC-6E at 1.25 lbs per acre; water run	6	32
EPTC-6E at 2.35 lbs per acre; water run	3	13
Granular, 1 lb per acre (not irrigated)	2	58
Granular, 2 lbs per acre (not irrigated)	1	28
Granular, 3 lbs per acre (not irrigated)	2	27
Check (irrigated)	10	20

alfalfa at the 3 lb rate. The test demonstrated that weed control is not as effective in water-runs as is the granular application; a better stand was established by bringing the alfalfa up with natural rainfall. Weeds in the trial were groundsel, shepherds purse, fiddleneck, mustard, nettle-leaf goosefoot, and volunteer oats. EPTC gave satisfactory control

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# WEED CONTROL IN SEEDLING ALFALFA

W. R. SALLEE

of all weeds except groundsel, mustard, and nettle-leaf goosefoot.

In the fall of 1963 a test was established using three materials—trifluralin (Treflan), EPTC, and bensulide (Prefar) as pre-emergence treatments. The purpose was to determine selectivity of the materials as well as weed control. The test plot was on heavy clay loam soil, and was evaluated January 28, 1964, for plant vigor. There were no weeds in the plot at that time.

Treatments and Rates	Rating*
Trifluralin 1/2 lb per acre	7
Trifluralin 3/4 lb per acre	5
Trifluralin 1 lb per acre	4
EPTC 1 lb per acre	10
EPTC 2 lbs per acre	9
EPTC 3 lbs per acre	9
Bensulide 5 lbs per acre	10
Bensulide 10 lbs per acre	10
Check	10

\* 0 = no plants; 10 = good stand.

Visual symptoms in the trifluralin plots showed slower growth and reduction of stand. At cutting time the visual symptoms had disappeared and there was no difference in the yields. Trifluralin at the 1 lb rate and bensulide at the 10 lb rate kept the plots free of weed grasses throughout the season. EPTC at the 3 lb rate controlled the grasses for only six weeks.

The following year the same type of plot was established on light sandy loam soil. One post-emergence herbicide, 2,4-DB (ester), was added. Fiddleneck was the major weed problem in the plot. The rating summary for insecticides tested follows (top of page):

Field where test plots were located showing treated area in foreground; untreated area in background. Material used: dinitro selective.

Herbicide	Plot Evaluation		
	Rate lbs per acre	Crop injury Rating*	Weed control Rating†
Trifluralin emulsifiable . 3/4		6	8
Trifluralin emulsifiable . 1		6	8
Trifluralin emulsifiable . 2		8	9
Trifluralin granular .... 1		2	3
Trifluralin granular .... 2		4	4
EPTC .....	2	0	6
EPTC .....	3	0	7
Bensulide .....	7	0	6
Bensulide .....	10	0	8
Check .....	0	0	1

\* Crop injury: 0 = no injury; 10 = plants dead.

† Weed control: 0 = no control; 10 = perfect control

All of these pre-emergence materials were incorporated with a disk and harrow. Weed control was only good enough to allow a good stand establishment. Trifluralin granular gave poor weed control, and the trifluralin emulsifiable caused severe damage to the stand. The 2,4-DB (ester) retarded growth of the weeds but did not control them.

A post-emergence plot was established in 1965 where common mustard and fiddleneck were a serious problem. The following table (top of page) is an evaluation at harvest time (using the same rating schedule as the previous table):

Material	Herbicide Rate lbs per acre	Green weight			Other weeds lbs	Total lbs
		Alfalfa lbs	Volunteer sugar beets lbs			
Bromoxynil .....	1/8	6.2	2.0	2.9	11.1	
Bromoxynil .....	1/4	7.5	0.5	1.2	9.2	
Bromoxynil .....	3/8	8.2	2.9	1.1	12.2	
Bromoxynil .....	1/2	8.1	2.5	0.3	10.9	
2,4-DB (ester) .....	3/4	9	0.4	0.4	9.8	
Dinitro ammonium salt 1 1/4		4.5	1.1	2.1	7.7	
Check .....	0	1.4	0.8	4.5	6.7	

Post-emergent weed control with 2,4-DB ester. Mustard in background crowded out alfalfa stand.

Herbicide	Rate lbs per acre	Crop injury Rating	Weed control Rating
2,4-DB (ester) ....	3/4	4	8
2,4-DB (ester) with wetting agent .	3/4	5	8
2,4-DB (amine) . .	3/4	3	5
2,4-DB (amine) with wetting agent .	3/4	3	6
Dinitro, amine salt ....	1 1/2	4	4
Dinitro, ammonium salt	3/4	4	7

The 2,4-DB (ester) gave satisfactory weed control. Weeds that this material failed to kill were stunted and did not grow over 8" in height. The 2,4-DB (amine) was much less effective than the 2,4-DB (ester). The dinitros appeared to control 80% of the weeds in the first two weeks after application, but by harvest time the weeds that were not killed, had grown to full maturity, and were a problem. The amine salt (pre-emerge) was inferior to the ammonium salt.

In the spring of 1966 another plot (3 x 13 ft) was established, and a new material—bromoxynil—was added. (In 1965 several log plots had shown excellent control of weeds, especially of fiddleneck, which encouraged further use of this material.) At harvest time the weeds were separated from the alfalfa and each was weighed (see table below). *Continued . . .*

Post-emergent weed control in alfalfa with Bromoxynil showing complete eradication of mustard and fiddleneck (plot clipped once.)



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### Weed Control in Seedling Alfalfa (Continued)

The major weeds in this plot were London rocket mustard, shepherd's purse, and volunteer sugar beets. The bromoxynil plots at  $\frac{3}{8}$  lb and  $\frac{1}{2}$  lb per acre were almost completely free of weeds, except for sugar beets; whereas 2,4-DB (ester) was effective on all weeds except for fiddle-neck.

On February 2, 1965, plots were established using three materials as pre-emergence treatments—EPTC, trifluralin, and a new material, benefin. All materials were incorporated in the soil at planting time with a Lilliston rolling cultivator.

The EPTC plots at 3 lbs per acre

showed some early damage to the alfalfa, but it was only temporary. Weed control was satisfactory for about six weeks. After that time watergrass emerged and was a problem in July, August, and September.

#### Trifluralin

The trifluralin plots showed minor injury to the alfalfa at  $\frac{1}{2}$  lb per acre, but 50% and more stand reduction at the 1- and 2-lb-per-acre rates. Grass was satisfactorily controlled with trifluralin, but the damage to the stand was too severe for it to be recommended as a safe material

to use as a pre-emergence herbicide in seedling alfalfa.

Benefin showed little damage to the alfalfa at lower rates, but some damage at the 3-lb rate. Control of broadleaf weeds was 85% and of grasses, nearly 100%. The 1-lb and 2-lb rates held the grasses under control throughout the production season. This material has a high degree of selectivity, and long residual action in the soil resulting in full-season weed control.

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