Managing Dryland Alfalfa / in Eastern Washington

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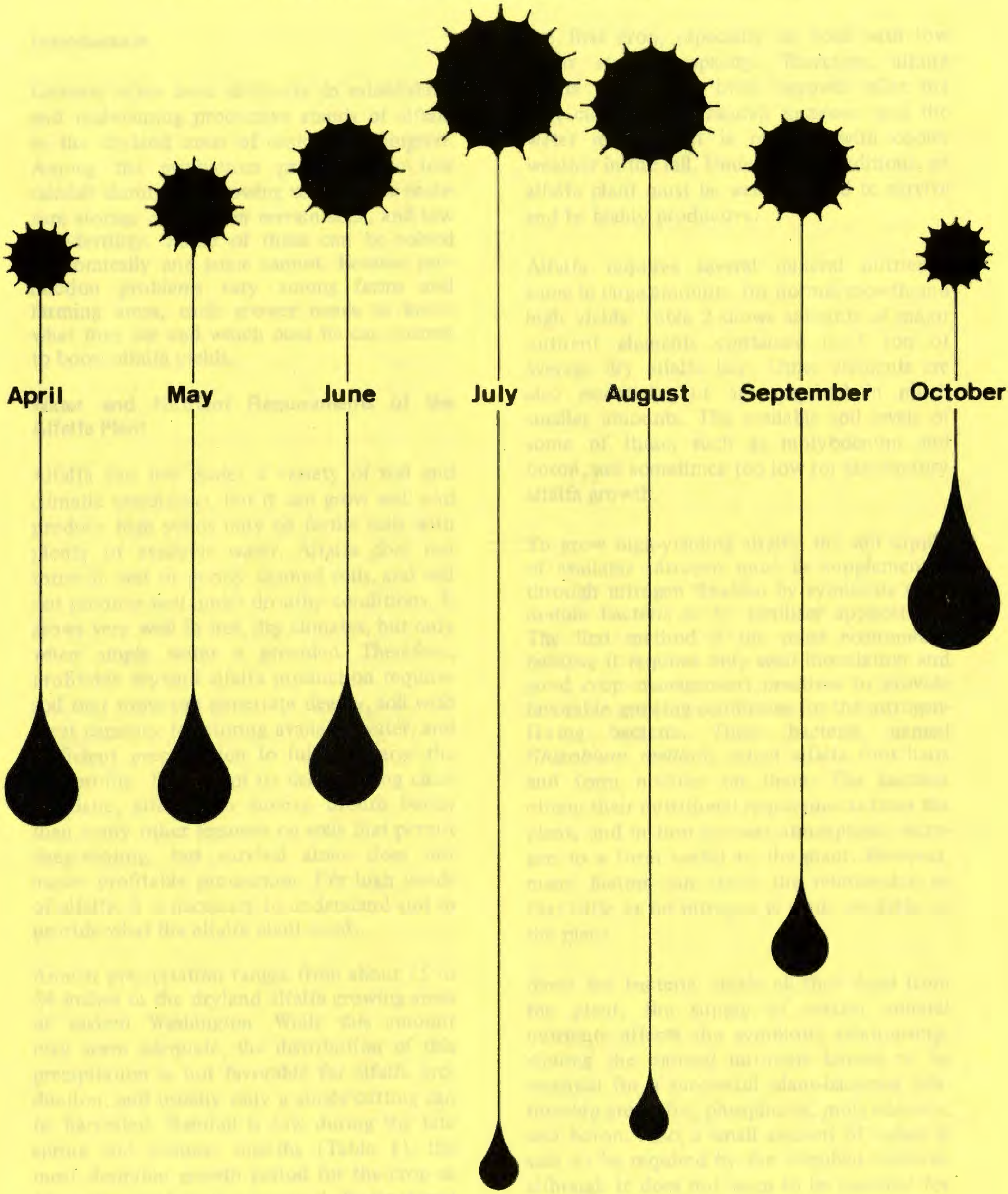

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MANAGING DRYLAND ALFALFA IN EASTERN WASHINGTON

Introduction

Growers often have difficulty in establishing and maintaining productive stands of alfalfa in the dryland areas of eastern Washington. Among the production problems are low rainfall during the growing season, low moisture storage capacity in certain soils, and low soil fertility. Some of these can be solved economically and some cannot. Because production problems vary among farms and farming areas, each grower needs to know what they are and which ones he can correct to boost alfalfa yields.

Water and Nutrient Requirements of the Alfalfa Plant

Alfalfa can live under a variety of soil and climatic conditions, but it can grow well and produce high yields only on fertile soils with plenty of available water. Alfalfa does not thrive in wet or poorly drained soils, and will not produce well under drouthy conditions. It grows very well in hot, dry climates, but only when ample water is provided. Therefore, profitable dryland alfalfa production requires soil that roots can penetrate deeply, soil with great capacity for storing available water, and sufficient precipitation to fully recharge the soil profile. Because of its deep-rooting characteristic, alfalfa can survive drouth better than many other legumes on soils that permit deep-rooting, but survival alone does not insure profitable production. For high yields of alfalfa, it is necessary to understand and to provide what the alfalfa plant needs.

Annual precipitation ranges from about 15 to 24 inches in the dryland alfalfa growing areas of eastern Washington. While this amount may seem adequate, the distribution of this precipitation is not favorable for alfalfa production, and usually only a single cutting can be harvested. Rainfall is low during the late spring and summer months (Table 1), the most desirable growth period for the crop as far as temperature is concerned. Water stored in the soil profile is often largely depleted by the first crop, especially on soils with low water storage capacity. Therefore, alfalfa plants often make little regrowth after the first cutting until rainfall increases and the water requirement is reduced with cooler weather in the fall. Under these conditions, an alfalfa plant must be well-managed to survive and be highly productive.

Alfalfa requires several mineral nutrients, some in large amounts, for normal growth and high yields. Table 2 shows amounts of major nutrient elements contained in 1 ton of average dry alfalfa hay. Other elements are also essential, but are required in much smaller amounts. The available soil levels of some of these, such as molybdenum and boron, are sometimes too low for satisfactory alfalfa growth.

To grow high-yielding alfalfa, the soil supply of available nitrogen must be supplemented through nitrogen fixation by symbiotic root-nodule bacteria or by fertilizer applications. The first method is the most economical, because it requires only seed inoculation and good crop management practices to provide favorable growing conditions for the nitrogen-fixing bacteria. These bacteria, named *Rhizobium meliloti*, infect alfalfa root hairs and form nodules on them. The bacteria obtain their nutritional requirements from the plant, and in turn convert atmospheric nitrogen to a form useful to the plant. However, many factors can affect the relationship so that little or no nitrogen is made available to the plant.

Since the bacteria obtain all their food from the plant, the supply of certain mineral nutrients affects the symbiotic relationship. Among the mineral nutrients known to be essential for a successful plant-bacterial relationship are sulfur, phosphorus, molybdenum, and boron. Also, a small amount of cobalt is said to be required by the rhizobial bacteria, although it does not seem to be essential for the alfalfa plant.

Although nutrient deficiencies or unfavorable environmental conditions will not necessarily kill an alfalfa plant, they may limit production. An alfalfa plant in stress, due to either nutritional or water limitations, is seldom well nodulated; hence, its nitrogen supply is restricted.

Soil and Weather Conditions in Eastern Washington

Soil and weather conditions in the dryland area of eastern Washington are often unfavorable for maximum hay production. Some of the soils used for growing alfalfa have a dense subsoil horizon 18 to 24 inches beneath the surface, others are underlain by basalt at depths of 20 inches to 5 feet, while still others have sandy or gravelly subsoils. These soil properties result in limited root growth, low available water holding capacity, or both. Coupled with low rainfall during the period of greatest crop growth, the result is that the alfalfa crop frequently experiences damaging moisture stress as it nears the harvest stage.

The drouthy summer environment is intensified by high daytime temperatures and low humidity causing a high crop moisture demand. The restricted summer moisture supply is especially detrimental to young seedlings during stand establishment and is also an important factor in stand longevity. Even in an established stand, weakened plants frequently succumb to late summer drouth, and plants weakened by summer drouth are especially susceptible to winterkilling. The result of combinations of these adverse soil and weather conditions often is loss of yield potential through stand depletion.

There are deep, fertile, medium-textured, well-drained soils in the area that can grow excellent alfalfa. However, even on these soils, improper management frequently results in yield reductions.

Management Factors

An alfalfa grower must use crop management techniques that will help him supply the needs of the alfalfa plant. Good management practices are especially important where soil and weather conditions are not ideal. The following suggestions will aid in the establishment and maintenance of productive alfalfa stands in eastern Washington.

Seedbed preparation and seeding: Alfalfa should be planted in the spring as soon as soil moisture and weather conditions permit. In the press of other activities, many farmers put off alfalfa planting until late spring. In a year with normal weather conditions, the moisture supply available to new seedings is materially reduced with each week's delay in seeding. In rapidly drying soils, seedling roots cannot penetrate deeply and the plants tend to become stunted and spindly. If the roots do not penetrate deeply during the first growing season, they usually never will. Spindly, weakened plants seldom survive the rigors of the seedling year and the first winter.

The seedbed should be finely worked, firm and moist. A recommended variety of alfalfa seed for the region should be inoculated and seeded ¼ to ½ inch deep at a seeding rate of 10-12 pounds per acre. At the present time the recommended variety is Ladak. A packer should be used to firm the soil surface when the seedbed is warm and drying rapidly.

The importance of using high-quality seed cannot be overemphasized. Good seed is likely to have a higher germination percentage and to produce plants of greater vigor than will low-quality seed. The use of certified seed gives added assurance that a good stand of high-yielding alfalfa will result. There is no substitute for good seed and early spring seeding.

Alfalfa should not be planted with companion crops, such as cereal grains or peas. Cover crop competition for the limited water supply during the seedling year reduces hay yields in the following crop year through stand reduction and loss of plant vigor.

Inoculation: To meet the nitrogen demands of alfalfa without fertilization, the symbiotic plant-bacteria relationship must be established by proper seed inoculation. Although most growers are aware of the need for seed inoculation, many do not understand the care required to achieve successful inoculation. As is true of many living organisms, *R. meliloti* has a high mortality rate when exposed to adverse conditions.

Inoculum for alfalfa is available through seed dealers. Good inoculum is inexpensive but essential to proper seed inoculation. The bacteria in the inoculum are extremely sensitive to high temperature, and should be stored in a cool dry place until used. A refrigerator is excellent for this purpose. If inoculum is suspected of having been exposed to direct sunlight or high temperature, it should be discarded. All inoculum is dated and should not be used after the expiration date. Mishandled inoculum is useless.

Inoculum should be mixed with the seed just prior to seeding. Only the amount of seed that can be used in one day should be inoculated at one time. Although this may be inconvenient, it helps to assure effective inoculation. The seed should be moistened with water, the proper amount of inoculum added, thoroughly mixed, and allowed to air dry in a shaded place. A good drying method is to spread the inoculated seed on a tarpaulin inside a building. While seeding, excess inoculated seed must be kept covered and out of direct sunlight. If all the inoculated seed cannot be used in one day, it should be reinoculated prior to its use.

The grower may wonder if inoculation is required in a field that has grown alfalfa in the past. The answer is *yes*. With the crop rotation systems used in eastern Washington, where alfalfa follows several years of wheat or peas and summer fallow, inoculation is important. *Rhizobium* numbers decline with time in the absence of the host plants. Even when alfalfa is reseeded, inoculation is good insurance.

A simple field examination will reveal whether *Rhizobium* bacteria which will infect alfalfa roots are present in an alfalfa field. After a two-week period of good moisture and rapid growth in an established alfalfa stand, the grower can dig up a few plants and check for nodulation. In new seedings, more growing time may be required. This digging should be done carefully to avoid stripping off the nodules or the fine roots on which they grow. Soil should be removed carefully, and the roots examined for clusters of the small irregular tumor-like growths called nodules. These will vary from pinhead-sized individual nodules to palm-shaped clusters ¼ to ¾-inch in diameter. These nodules contain the nitrogen-fixing *Rhizobium* bacteria. If the bacteria are healthy and are actively fixing nitrogen, the interior of the nodules will be pink or red.

Effective nodules will be found on the plant only when it is growing well. They will normally not be found for a time after clipping, during a drouth, or if the soil is water-logged.

Mineral Nutrition: The nitrogen requirement of mature alfalfa plants is easily met through the activity of nitrogen-fixing bacteria when growth conditions are favorable. However, plants also need a readily available supply of nitrogen during the early seedling stage, before root nodules become established. The amount of fertilizer nitrogen required to satisfy crop demands at this stage of growth is not large; 20 pounds per acre applied during seedbed preparation is adequate.

The levels of available mineral nutrients in soils can be measured with chemical soil tests in most cases, and fertilizer applications should be based on soil tests whenever possible. In eastern Washington, supplies of available phosphorus, sulfur, and boron are often deficient. Lime applications are sometimes beneficial, partly because of alfalfa's high calcium requirement (see Table 2) but also because of the more favorable availability status of other nutrients which results from the effect of lime on soil acidity. Responses to lime in field trials have been quite variable, but are most likely to be obtained on soils developed under forest vegetation, which are more prevalent at higher elevations in the extreme eastern part of Washington.

Phosphorus is very important to the early development of vigorous and extensive root systems. As noted earlier, a good root system is one of the most essential factors for survival of summer drouth by alfalfa seedlings. Soil tests will help determine the amount of phosphorus fertilizer that should be applied to promote root growth.

Alfalfa responds to sulfur applications on most soils in this area. A sulfur deficiency can usually be corrected by annual broadcast applications of 150 pounds per acre of gypsum, although other commonly used fertilizer materials also contain sulfur and may meet at least part of this requirement. Where soil boron or molybdenum supplies are known to be deficient, gypsum to which these elements have been added can be used.

Detailed recommendations on specific soil fertility problems can be obtained from the County Extension Agent, and from written Fertilizer Guides published by the Cooperative Extension Service of the College of Agriculture, Washington State University.

Weed Control: Alfalfa seedlings may be severely weakened or lost due to weed competition. Although there is no substitute for a clean, weed-free seedbed, competition may be reduced by mowing as the stand becomes established. Satisfactory weed control can be obtained on mature stands by using selective herbicides.

Since herbicide technology is in a state of rapid development and frequent change, the County Agricultural Extension Agent or Weed Specialist should be consulted for current recommendations. If you decide to use a herbicide, carefully read and follow directions and precautions printed on its container.

In old stands which have become thin, bluegrass and other weeds increase and compete for the water supply. The use of a springtooth cultivator in early spring to kill these weeds is a common practice, but is not recommended. The value of this practice is questionable, and unless it is done carefully, much damage may result. If cultivation is deep, branch roots may be pruned. Also, crowns may be split or broken, and this increases opportunities for disease organisms to infect the plants. The shock of root pruning and crown damage may also delay the development of effective root nodules for nitrogen fixation.

Cutting and Grazing: The management of alfalfa harvest is very important to the grower and to the feeder, as it affects stand longevity and hay quality.

To maintain health, vigor, drouth resistance, and winter hardiness, an alfalfa stand must store large amounts of carbohydrate and protein food reserves in the plant roots. The greatest root reserves are usually attained at or near full bloom stage, but total hay yield and hay quality are highest at an earlier stage. A good balance between stand maintenance, high yields, and quality of hay can be obtained by cutting alfalfa no later than the one-fourth bloom stage, or when new bud growth begins to emerge from the crown. Moreover, alfalfa in late to full bloom stages in eastern Washington has often shed many leaves due to moisture stress, and this further reduces hay quality.

In eastern Washington, alfalfa normally becomes dormant after the first cutting, or makes a limited regrowth which may not be sufficient for a second cutting, and then becomes dormant. It will break dormancy when fall rains begin, grow briefly, and go dormant again with frost and cold weather.

Growers often allow livestock to graze alfalfa fields during the summer dormant period, and during the fall and early spring growth periods. Such grazing, especially during the fall growth period, is a severe test of alfalfa's persistence. Good fall regrowth is necessary for replenishing root reserve food supplies, and is essential for overwinter survival. Animals continually remove new growth which is produced at the expense of the roots' carbohydrate and protein reserves; rapid loss of stand and reduced yields may be expected under this kind of management. Moreover, since the development of new root nodules for nitrogen fixation does not occur until regrowth is well developed, prolonged grazing results in both carbohydrate and nitrogen deficiencies.

Irrigation: Although this publication is intended to deal with the management of dryland alfalfa, some alfalfa is grown with supplemental irrigation in eastern Washington. This practice may increase, although the supply of water for irrigation is limited. Supplemental irrigation is most likely to be used on the broad, more or less level stream valleys, where water can be obtained by pumping from surface streams or shallow wells. The amount of water to apply and the frequency of application depend on local weather and soil conditions. Under mid-summer conditions of bright sunshine and high air temperatures, a dense stand of growing alfalfa may remove one-third inch or more of water from a moist soil in a day.

In sandy or gravelly soils, and in dense, heavy subsoils, water moves to the roots very slowly after partial drying. The soil water supply then cannot keep pace with the demand, and the crop will begin to suffer moisture stress when only part of the available water in the rooting depth has been depleted. Therefore, it is necessary to apply supplemental water frequently on such soils to keep an alfalfa crop well nodulated and growing vigorously.

Summary

A summary of the steps required to manage alfalfa in dryland areas of eastern Washington is as follows:

1. Prepare seedbed and plant high-quality inoculated seed without a companion crop as early in the spring as possible. Handle the inoculum with care to keep it alive and effective.
2. Apply fertilizers as needed to meet crop requirements, based on soil tests. Give particular attention to lime, phosphorus, and sulfur deficiencies; boron or molybdenum deficiencies may occur in certain areas.
3. Control weeds by mowing, or with herbicides as recommended by your County Extension Agent.
4. Do not cultivate or graze alfalfa stands intended for hay production; harvest at an early bloom stage.
5. Supplemental irrigation is beneficial; if limited water is available, use it for stand establishment.

Prepared by L. C. Johnson, Research Soil Scientist, Agricultural Research Service, U.S.D.A., Pullman, Washington; L. F. Elliott, Research Microbiologist, Agricultural Research Service, U.S.D.A., Prosser, Washington; and C. D. Fanning, Extension Soils Specialist, Washington State University, Pullman, Washington.

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TABLE 1.

Average inches of precipitation received at selected locations in eastern Washington and at Potlatch, Idaho, by months. The dashed line emphasizes the very low amounts of rainfall received during the growing period.

	Goldendale	Walla Walla	Sprague	Deer Park	Pullman	Potlatch, Idaho
January	2.93	1.89	1.81	2.90	2.67	3.10
February	2.03	1.52	1.32	2.11	2.10	2.35
March	1.70	1.59	1.32	1.86	2.12	2.28
April	0.85	1.40	0.94	1.53	1.49	1.82
May	0.79	1.49	1.16	1.67	1.46	1.94
June	0.91	1.22	1.14	1.52	1.54	2.06
July	0.15	0.21	0.33	0.47	0.39	0.55
August	0.21	0.30	0.42	0.58	0.52	0.52
September	0.62	0.78	0.83	1.18	1.08	1.38
October	1.64	1.53	1.55	2.22	1.91	2.33
November	2.53	1.72	1.84	2.75	2.47	2.80
December	3.05	1.85	2.04	3.24	2.74	3.36
Total	17.41	15.50	14.70	22.03	20.49	24.49

TABLE 2.

Approximate pounds of major nutrient elements in one ton of dry alfalfa hay[1]

Calcium	33
Phosphorus	5
Potassium	35
Sulfur	7
Magnesium	6
Nitrogen	55

[1] *From: Composition of Cereal Grains and Forages, Publication 585. National Academy of Sciences, National Research Council, June, 1958.*