CONSIDERATIONS DURING ALFALFA ESTABLISHMENT

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Abstract: The profitability of alfalfa is contingent upon establishing a dense vigorous stand of alfalfa. A deep uniform soil is preferred for non restricted root growth and optimum alfalfa development. Problems with layered soils or hard pans can be corrected with deep tillage, but the costs and benefits must be carefully evaluated. A level firm seedbed and shallow seeding, 0.25 to 0.5 inches, are essential for successful alfalfa stand establishment. Seeding rates of 15 to 25 pounds per acre (higher rates for broadcast seedings) are recommended, as no difference in yield or stand occurs over a wide range of seeding rates. Predicted optimum planting dates are in the early fall for most production areas. Deviating from optimum planting dates may result in significant long-term yield losses. Maintaining soil moisture and fertility levels are important to avoid plant stress. Weed competition should be minimized. Alfalfa should not be cut until the root system is at least 14 inches deep and the plant has developed three or more stems.

Keywords: Planting, seedbed preparation, tillage, planting method, seeding depth and rate, planting date, fertilization, weed control, first cutting

INTRODUCTION

Successful alfalfa stand establishment is the first step toward obtaining a long-lived productive alfalfa field. Improper alfalfa stand establishment practices can reduce the profitability of alfalfa by lowering yields, diminishing stand life, and reducing the nutritional quality of the hay. Much attention is paid to selecting the highest producing best adapted alfalfa variety. However, the genetic potential of improved varieties may never be realized if another factor, such as poor stand establishment, limits yield. There are several common reasons for unsuccessful alfalfa stand establishment. Many of the important factors to consider when establishing alfalfa and the common causes of failure are discussed below.

SEEDBED PREPARATION

A difficult question to answer can be what type or degree of tillage is required prior to planting alfalfa. Unfortunately, there is no single "recipe" for seedbed preparation that is appropriate for all locations. Alfalfa requires well-drained relatively deep soil (a minimum of 3 to 4 feet) for maximum production. Physical or chemical limitations to rooting depths caused by hard pans, stratified soils, or salts restrict productivity and lower yields. Root development can occur to depths of 6 to 12 feet provided that restrictive layers, a high water table, high salts, or poor drainage do not exist.

Deep Tillage

The economic returns of deep tillage can be difficult to predict. Perhaps the best method to assess the need for deep tillage is to utilize an understanding of the nature of the soils in the area coupled with previous crop history. Soil surveys or a knowledge of local soil types may indicate

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that soils are stratified and may benefit from subsoiling. Using a backhoe prior to removing an old stand of alfalfa enables one to observe the distribution of alfalfa roots in the soil profile and is a good indicator if soil stratification or impermeable layers are a problem. A lot can be learned by looking at the roots of an old field prior to removal.

Several deep tillage implements have been used and evaluated in alfalfa, including moldboard plow, deep ripper, and slip plow. Most of the experience with these tillage instruments has been in the Imperial and Palo Verde Valleys. The potential benefits to alfalfa from deep tillage have not been adequately evaluated in other parts of California. Yield increases from deep tillage have been phenomenal in studies conducted in the Imperial Valley. First year yield on a fine sandy loam soil was 4.6 tons per acre (T/A) where the soil was only disced to an 8 inch depth compared to 7.2 T/A from slip plowing 3 feet deep, 11.2 T/A from slip plowing in two directions, and 9.4 T/A from moldboard plowing. Studies conducted on heavier soils showed less dramatic yield increases. It is not well understood how long the effects of deep tillage will last, but data from Texas still showed effects from deep tillage 12 years later.

The advisability of deep tillage is primarily a question of economics: will the benefits exceed the cost? The cost of deep tillage varies depending on the power requirement and desired depth of tillage, but often costs as much as $200 per acre or more. Yield increases of the magnitude mentioned in the Imperial Valley studies would not be expected on more uniform deeper soils which may be more typical of California's central valley. However, ripping to more moderate depths, 20 - 32 inches, is still recommended to reduce compaction that may have occurred from preceding crops. Ripping should only be done when the soil is dry for maximum fracturing, as ripping wet soils does not fracture compacted layers.

The necessity of plowing to prepare a seedbed for alfalfa is questionable. Plowing can be useful to remove old alfalfa stands, bury weed seeds and plant debris, and for deep incorporation of fertilizer. However, plowing can sometimes bring up less desirable soil and is especially problematic in rocky soils. Extra tillage and/or time is required to firm up or settle the soil after plowing. An excellent alfalfa seedbed can be prepared without plowing under most circumstances.

Field Leveling

Leveling the field is important. The degree of leveling that is needed primarily depends on the type of irrigation system that will be used and soil type. If the field is sprinkler irrigated, the low spots will need to filled and leveled so that water does not pond and drown out the alfalfa. However, more extensive leveling is required for fields with border strip flood irrigation systems. Laser leveling has increased in popularity and is the preferred method for flood irrigation.

Seed Placement

One of the most common reasons for alfalfa stand establishment failures is seeding depth. Seeding too deep is almost always the problem. Seed placement is related to the condition of the seedbed prior to planting. An alfalfa seedbed should be firm, not powdery or fluffy, and relatively clod free. It should be firm enough so that your heel print in the prepared soil will not be more than 1/2 inch deep. This can be accomplished by harrowing and cultipacking the field prior to seeding. After the seedbed is formed, shallow placement of alfalfa seed is essential to ensure good emergence. Maximum emergence generally occurs at depths of 0.25 to 0.75 inches. In a study conducted in Fresno County, only 2% of the seed planted 2.5 inches deep emerged, whereas

70% emergence was achieved with seed planted 0.25 to 0.5 inches deep Slightly deeper seed placement is permissible on sandy soils.

Of almost equal importance to seeding depth is incorporation and firming of the seedbed after planting. Good seed-soil contact is important to prevent desiccation of the emerging alfalfa seedling. Cultipacking or ring rolling once after seeding is usually sufficient, however, cultipacking twice can be beneficial, particularly on many lighter textured soils.

SEEDING RATE

Numerous studies have been conducted in California and throughout the United States to determine the optimum seeding rate. Most studies have concluded that a wide range of seeding rates are acceptable provided good seedbed conditions. One pound of alfalfa seed spread evenly over and acre equates to approximately 5 seeds per square foot. Twenty alfalfa seedlings per square foot is considered to be an adequate stand. Why then are seeding rates so much higher than what is needed to supply 20 seeds per square foot? Typically, only 60 percent of the seeds germinate and emerge and an additional 60 percent die during the first year. The survival rate is higher with lower seeding rates (Table 1). Therefore, higher seeding rates generally do not result in improved yields or alfalfa stand density except under the poorest of seedbed conditions. Adequate stands have been established with seeding rates as low as 12 to 15 lbs per acre under ideal conditions. However, to compensate for less than ideal conditions and unforeseen weather, general seeding rates recommendations for California are 15 to 20 pounds when drilled and 20 to 25 pounds per acre for broadcast seedings. An extra few pounds of seed is generally not too costly, and is cheap insurance against less than optimum seedbed and weather conditions.

SEEDING METHOD

Several methods of planting alfalfa are used successfully in California. Alfalfa may be seeded broadcast or drilled. A cultipacker seeder, such as the Brillion Seeder, is often used with excellent results. The advantage of this technique is that it employs a double corrugated roller. The leading roller breaks clods and firms the soil prior to seeding. The trailing roller splits the ridges made by the first roller which serves to cover the seed and further firm the seedbed. The primary disadvantage to this method is the time required to seed the alfalfa. Other techniques commonly used for broadcasting alfalfa seed are to fly on the seed, use an air flow ground applicator, or use the grass seed attachment of a grain drill allowing the seed to fall out of the seed tubes and scatter on the ground. After the seed is broadcast, a cultipacker or ringroller is used to cover the seed.

Many growers elect to drill alfalfa seed using a grain drill. To my knowledge, trials have not been conducted in California comparing the relative effectiveness of broadcast versus drilled alfalfa seedings. There are advantages and disadvantages to each method. Broadcast seeding is generally faster, but a fair amount of seed can remain uncovered on the soil surface. Broadcasting also distributes the seed more uniformly. The disadvantage for drilled seeding is the difficulty in controlling seeding depth and the distance between rows of alfalfa seedlings, particularly if there is a skip in one of the drill rows, thus, doubling the distance between plants. To overcome this potential problem, some growers have opted to drill in two directions. An advantage of drilled plantings is that phosphorus fertilizers can be drilled with the seed. Also, less soil moisture is lost with drilled than broadcast planting methods, which can be particularly important where growers depend on rainfall for crop emergence. However, any of the seeding methods mentioned can be

successful provided the seedbed is properly prepared and seeding depth controlled. Research is in progress that will add to our understanding of the advantages and disadvantages of each of the methods.

PLANTING DATE

Many factors need to be considered when selecting the date to plant alfalfa. Such factors include weather (primarily temperature and likelihood of rainfall), the cropping pattern, harvest date of the preceding crop, water availability, the irrigation system, weed pressure, and most importantly the needs of the crop. Dr. Larry Teuber et. al. have developed a procedure for determining the optimum alfalfa planting date for different regions of California. The most desirable planting date is determined by matching the optimum soil temperature and photoperiod for seedling development with historical climatic conditions for a specific location.

Optimum soil temperature and photoperiod occur in both the spring and fall. However, fall plantings are preferred, as a fall planting is followed by cool temperatures and reduced photoperiod which promotes crown buds and root formation. This method has been tested in only a few parts of the state, but data from Imperial, Fresno, and Yolo counties support this approach. The effects of planting date are significant (Tables 2 and 3). These effects are not short-lived, extending well beyond the first harvest year. Suggested planting dates (Figure 1) favor the development of alfalfa and often fall between the typical emergence periods for summer and winter annual weeds. Thus, fewer weeds may be present, and the alfalfa has a competitive advantage over weeds that do emerge.

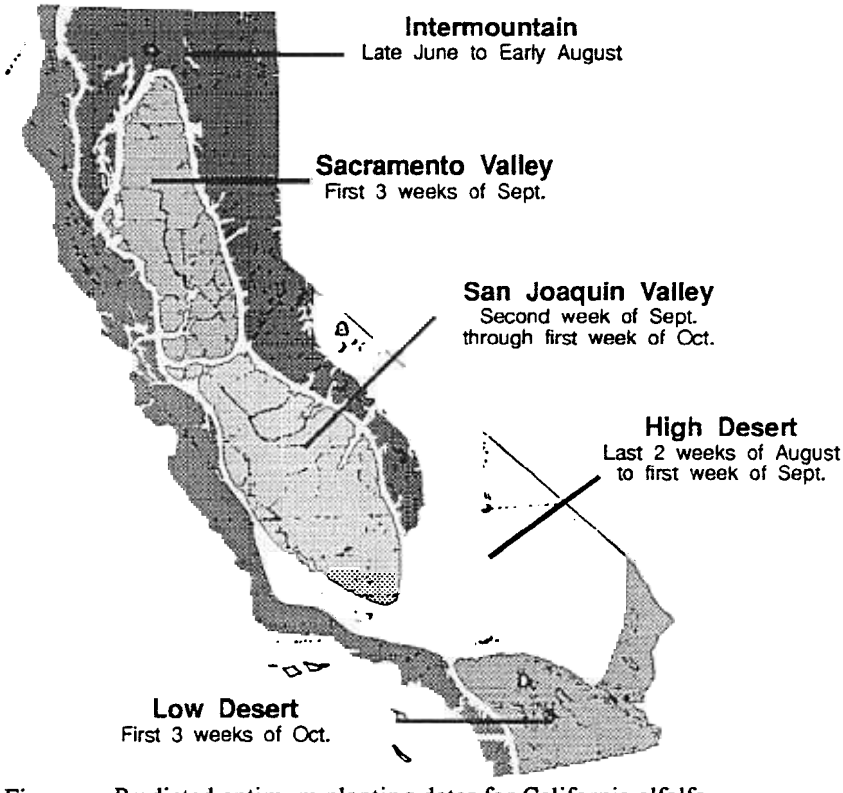

Figure Predicted optimum planting dates for California alfalfa production regions.

While these dates are considered to be optimum for alfalfa seedling development, other constraints may alter the preferred planting date. For example, harvest of the previous crop, such as cotton, may influence when alfalfa can be planted. Planting in early fall can be difficult for some growers with flood-irrigated fields who rely on rainfall to germinate the crop. Certain diseases, such as sclerotinia, can be a problem in early fall plantings when significant alfalfa canopy is present during a period of cool moist weather. Growers must weigh the potential benefits from planting alfalfa at the optimum time against the potential cost or losses, such as irrigation costs or loss of income from other crops.

FERTILIZATION

Adequate soil fertility is a fundamental component of successful stand establishment. Seedling vigor is important and better enables alfalfa to compete with weeds. Soil analysis should be used to assess soil fertility prior to planting. The phosphorus and potassium status of the soil can be accurately determined with soil analysis. Potassium is rarely deficient for alfalfa production in California soils. In contrast, phosphorus is commonly deficient and is particularly important when establishing alfalfa. If soils are deficient, it is recommended to apply a one to two year supply of phosphorus at planting time. The fertilizer can be broadcast and disced or harrowed for incorporation or, for drilled plantings, good results have been obtained banding phosphorus with the seed. This method places the phosphorus in a location where it is readily available to the plant and less of the fertilizer is likely to be tied up in soil reactions.

Fertilizing seedling alfalfa with nitrogen has been debated for years. A recent article reviewed the literature on this topic to determine under what conditions nitrogen (N) fertilization of seedling alfalfa is beneficial. It was concluded that when soil nitrate levels were greater than 15 ppm and conditions were favorable for effective nodulation (soil pH of 6.2 to 7.5 and sufficient Rhizobium bacteria present), N fertilization did not result in economically important yield increases. A yield increase in the seeding year is likely under poor nodulation conditions or when soil nitrate levels are below 15 ppm or organic matter content is below 1.5%. A response to N fertilizer is more likely when soil temperatures are cool (less than 60^{o} F) for several weeks after planting. Under this circumstances, small amounts of N fertilizer (10 -50 lbs) would be beneficial. However, N availability greater than 50 lb/A will inhibit nodulation and delay crop development. Growers must be cautioned that N fertilization may promote weed growth and, for this reason, the general recommendation in California has been for preplant N rates not to exceed 20 lbs per acre.

IRRIGATION

It is important that the soil remain moist, not dry or wet, while the alfalfa is germinating and during initial seedling development. It is impossible to provide an irrigation schedule that would be adequate for all situations, given the variability in soil types, weather, and planting dates that occur in a state as diverse as California. The important point to remember is that the seedling alfalfa plants are not as resilient as established plants and should not be stressed, either from too much or not enough water. Some growers let seedling alfalfa fields become dry, trying to force the roots to grow deeper. This is not a recommended practice. Remember...plant roots grow in the presence of water, not in search of it.

COMPANION CROPS

Small grains, primarily oats, are sometimes planted as a companion crop during alfalfa establishment. While this has been a standard practice in some of the mid regions of the United States, it is considered a controversial practice in California. The proposed benefits of a companion crop are increased forage yields the first cutting of the seeding year, weed control, and wind and frost protection. The risk associated with companion seedings is excessive competition, thus reducing alfalfa stand and vigor.

Field trials conducted in many of the alfalfa production regions of California have led to some generalizations regarding the use of a companion crop. An oat companion crop displaces but generally does not eliminate weeds in the first harvest. Oats increase forage yields the first cutting, but alfalfa yields are generally reduced for the subsequent cutting or two. Total forage yields for the seeding year are often higher because of the contribution from the oats in the first cutting. Oat seeding rates should be low, approximately 8 to 16 lbs./A, or excessive competition will likely occur. The advisability of an oat companion crop can depend on the planting date of the alfalfa, the dormancy of the alfalfa, the oat seeding rate, and possibly the variety of oats and their height. Each of these can affect the competitive relationship between the alfalfa and the oats. The field should be cut based on the maturity of the alfalfa and not the oats, unless significant shading of the alfalfa occurs; in which case, the crop should be harvested early. A practice that is being used in other areas of the country is to seed a companion crop and chemically control it (using a selective herbicide such as Poast®) at a young growth stage before it competes with the alfalfa. Whether a companion crop is used or not, it is important to remember that the primary goal when seeding alfalfa is to establish a long-lived productive stand of alfalfa. The short-term benefits of a companion crop can be nullified if the alfalfa stand or vigor suffer from competition.

WEED CONTROL

Weed control during alfalfa stand establishment can be critical. Weeds compete with alfalfa for light, water, and nutrients. Weeds can reduce the vigor of seedling alfalfa and, in some cases, reduce alfalfa plant density to such a degree that the field has to be replanted. Weeds can also reduce the nutritional quality of the forage.

Preplant irrigation followed by light cultivation controls weeds, but generally does not eliminate them. Weeds can also be controlled using pre or post emergence herbicides. Effective weed management programs for seedling alfalfa have been developed and are discussed in detail in previous Alfalfa Symposium proceedings and UC publications.

The economics of using herbicides in seedling alfalfa are not always clear and may vary by field or area. Many factors are involved, including cost of the herbicides, the weed spectrum controlled by the herbicide, the price of "clean" versus "weedy" hay, the weed density, the weed species encountered and their characteristics (growth pattern, life cycle, toxicity, etc.) as well as the dormancy of the alfalfa and anticipated first cutting yields. Seedling weed control may be less cost-effective in the low desert where the very non-dormant alfalfa varieties produced there compete better with winter annual weeds and first cutting yields of seedling alfalfa fields are often very low. Seedling alfalfa fields in the low desert are commonly grazed with sheep instead of using herbicides. In contrast, herbicides are a necessity in many other areas of the state where alfalfa is less competitive with weeds. The key in any area is to minimize weed competition by whichever means is most feasible to improve alfalfa vigor and stand density.

TIMING OF THE FIRST HARVEST

The last step in alfalfa stand establishment is deciding when to make the first cutting. Alfalfa stores carbohydrates produced during photosynthesis in its roots (commonly called root reserves). These stored carbohydrate root reserves provide the energy for regrowth after cutting. Cutting alfalfa prematurely does not allow sufficient time for root reserves to accumulate and alfalfa vigor and the yield of subsequent cuttings may be reduced. Alfalfa should be "established" prior to the

first cutting. The appearance of bloom has been used as an indicator of "established" alfalfa. However, the number of stems is a far better criteria. Seedling alfalfa should not be cut until it has developed at least three stems. It has also been recommended that the roots of alfalfa grown on sandy or sandy loam soils be at least 14 inches deep prior to the first harvest to avoid impedance of root development. If growers are forced to cut alfalfa prematurely to remove weeds, or for any other reason, the interval between the first and second cuttings should be lengthened to allow the young alfalfa plant sufficient time to replenish depleted root reserves.

CONCLUSION

Alfalfa is considered by many to be a very forgiving crop compared with vegetables or many other small-seeded annual crops. Mistakes made during planting and stand establishment are often visually undetectable after the first cutting or after the first year of production. Although differences may be hard to detect, poor stand establishment may easily result in losses of 1/4 to 1/2 ton per year over the life of the stand. Alfalfa does have the ability to compensate for loss of stand to some degree, but severe stand or vigor loss increases weed invasion and reduces yield and quality. The goal during establishment should be to establish a vigorous dense population of alfalfa to compete with weeds and to form sufficient photosynthetic canopy to attain a long-lived productive and profitable alfalfa field.

REFERENCES

Curran, B.S., K.D. Kephart, and E.K. Twidwell, 1993 Oat Companion Crop Management in Alfalfa Establishment. Agron. J. 85:998-1003.

Hannaway, D. B. and P.E. Shuler. 1993 Nitrogen Fertilization in Alfalfa Production. J. Prod. Agric. Vol 6, no. 1.

Marble, V.L., 1990. Factors to Optimize Alfalfa Production in the 1990's. Proceedings 20th California Alfalfa Symposium. pp. 4-45.

Meek, B.D. 1978. Effect of Deep Tillage on Alfalfa Yields. Proceedings 8th California Alfalfa Symposium. pp. 65-66.

Mueller, S. 1992. Stand Establishment. In Central San Joaquin Valley Alfalfa Establishment and Production. S. Mueller, C. Frate, and R. Vargas (eds.). University of California Cooperative Extension Fresno, Tulare, and Madera Counties. pp. 16-19.

Schoner, C., W. Knipe, and F. Autio. 1979. Alfalfa, Time of Planting. Proceedings 9th California Alfalfa Symposium. pp. 1-6.

Sheesley, W.R. 1982. Timing of First Alfalfa Harvest to Avoid Impedance of Root Growth. Proceedings 12th California Alfalfa Symposium. pp. 47-49.

Tesar, M.B. and V.L. Marble, 1988. Alfalfa Establishment. In Alfalfa and Alfalfa Improvement. A.A. Hanson, D.K. Barnes, and R.R. Hill, Jr. (eds.). American Society of Agronomy publication 29. Madison, WI. pp. 303-332.

Teuber, L., J. Jernstedt, and K. Foord, 1987. Alfalfa Growth and Development. Proceedings 17th California Alfalfa Symposium. pp. 63-68.

White, H., D. Ball, G. Lacefield, and T. Johnson. Establishing Alfalfa Stands. Certified Alfalfa Seed Council Publication. P.O. Box 1017, Davis, CA.

Table 1. Effect of Seeding Rate on Alfalfa Plant Density and Yield the First and Second Year After Seeding. West Side Field Station, 1979-1981. (Marble and Peterson).

Seeding Rate	1 month after planting	1 year after planting	Percent Survival	1980 Yield	1981 Yield	Total Yield
	----Plants per sq. ft.----				-Tons dry matter/A--------	
	12.7	8.4	66.3	5.15	6.33	11.48
	21.9	9.5	43.5	5.15	6.49	11.64
	30.0	10.7	35.8	5.22	6.58	11.80
	35.4	11.2	31.8	5.11	6.61	11.72
	3.2	2.7			0.17	

Table 2. Effect of Planting Date on Total Seasonal Yield of First and Second Production Years. West Side Field Station, 1980 and 1981. (Marble and Peterson).

Planting Date	1980	1981	Total	2-year loss
	----------tons dry matter/acre----------			
9/18	7.36	7.51	14.87	0.00
10/18	--	6.41	--	(1.10)[1]
11/14	6.38	6.49	12.87	2.00
12/13	4.59	6.09	10.68	4.19
4/11	4.53	6.30	10.83	4.04
5/28	2.95	6.21	9.16	5.71
	0.72	0.61		

[1]Second year only. No first year data taken due to irregular stand.

Table 3. Effect of Planting Date on Total Seasonal Yield of First and Second Production Years. Woodland, 1978 and 1979. (Schoner, Knipe, and Autio).

Planting Date	1978	1979	Total	2-year loss
		---tons dry matter/acre----------		
9/14	7.28	8.19	15.47	0.00
10/17	6.54	7.88	14.42	1.05
11/16	5.60	7.44	13.04	2.43
3/21	4.00	7.33	11.33	4.14
		0.39	0.80	