Choosing an Alfalfa Variety

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Chapter 5

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Variety selection is an important decision in alfalfa production, affecting crop yield, crop quality, and pest management. Alfalfa varieties grown under the same conditions may differ up to 30 percent in yield. Returns from a simple process of variety selection can be worth hundreds of dollars per unit of land area. Some growers do not take the trouble to compare varieties and lose thousands of dollars in revenue as a result. They seldom recognize this loss, since deficiencies in varieties are difficult to see without a means of comparison. Because alfalfa is a perennial crop, growers are stuck with their choice for many years.

Selecting an alfalfa variety is a primary step in an integrated pest management (IPM) program for alfalfa. Breeders have successfully developed alfalfa lines resistant to insects, diseases, and nematodes, more so perhaps, than all other crops. Variety selection is often the *only* cost-effective measure for dealing with some insects and diseases. It is important for growers to take advantage of decades of plant breeding that has made pest-resistant, high-yielding, high-quality varieties available.

Many varieties are available, and new ones become available each year. This makes variety selection a challenge. Here, a scientific approach to variety selection that weighs the importance of yield, persistence, quality, and pest resistance is suggested.

What Is an Alfalfa Variety?

An alfalfa variety represents a population of plants consisting of genetically diverse individuals that have been selected for improved traits, such as yield, fall dormancy, forage quality, persistence, and disease and insect resistance. During the past five decades, plant breeders have made remarkable advances using conventional crossing techniques, hybridization, screening methods for specific traits, and more recently, biotechnology. Significant improvements have been made in adapting alfalfa to many environments. These improvements came from selection for fall dormancy and resistance to insects such as aphids and diseases like Phytophthora. In 2005, the first transgenic alfalfa varieties containing the Roundup Ready (RR) biotech trait were commercialized.

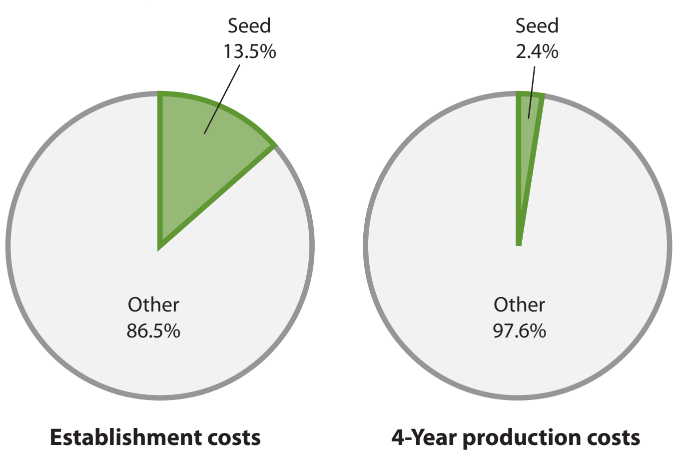
Certified seed of over 300 alfalfa varieties (also called cultivars) are actively marketed in the United States, and over a thousand have been produced during the past 50 years. A listing of marketed alfalfa varieties, including their fall dormancy and pest-resistance rating, is maintained by the National Alfalfa and Forage Alliance (www.alfalfa.org). A history of variety releases is maintained by the North American Alfalfa Improvement Conference (www.naaic.org).

Although alfalfa fields appear to be completely uniform from a distance, careful observation indicates considerable plant-to-plant variation. This variation is due primarily to genetic diversity that has been maintained by the inheritance and methods of breeding. Unlike varieties of some species that are composed of genetically uniform plants, alfalfa cultivars are diverse populations of plants (multiple genotypes). Alfalfa is a polyploid (alfalfa plants have four complete sets of chromosomes, whereas most crop plants have two sets), which means that the offspring of alfalfa crosses are much more diverse than most crop species. This genetic diversity has been a major asset, enabling alfalfa varieties to be well adapted over a wide range of environments, and to resist a wide range of insects, diseases, and nematodes to a greater degree than any other crop.

Modern alfalfa varieties, however, are still populations rather than uniform genetic strains. These populations have traits such as yield, fall dormancy, and pest and disease resistance that are significantly different from older, unimproved lines. But individual plants within a variety are not genetically identical. A trait is present in certain frequencies in the population of plants within a variety. This is pertinent, especially to the issue of pest resistance, since some susceptible plants remain in even highly resistant varieties, and some low-yielding plants remain in a high-yielding variety. Understanding the nature of alfalfa varieties as populations of many different types of plants is very important when evaluating variety performance with regard to adaptation, yield, fall dormancy, and pest and disease ratings.

FIGURE 5.1

Seed cost as a percentage of production costs during stand establishment (left) and production costs over 4 years of production (right).



Economics of Variety Choice

Alfalfa seed cost currently varies between approximately $1.00 and $4.50 per pound ($2–$10 per kg), not including technology fees from biotech traits. However, seed cost is a relatively insignificant part of production costs, generally around 2–3 percent of total production costs over 4 years (Fig. 5.1). One-tenth of a ton (200 lb or 91 kg of hay) improvement in yield per year is all that is required to justify even a $2 per pound ($2.50 per kg) increase in the price of seed (Fig. 5.2). Differences in variety performance in forage yield trials conducted by the University of California and other universities are nearly always many times this amount (Fig. 5.2). An example from the Kearney Research and Extension Center, near Fresno, California, shows that variety choice can generate hundreds of dollars per acre returns per year compared with planting lower yielding varieties (Fig. 5.3). Although it is true that other characteristics in addition to yield are important, and many factors other than variety may affect performance on growers' fields, it is clear that variety performance, not

FIGURE 5.2

Yield difference (tons per acre per year) required to justify increases in seed price of improved varieties (left) compared with average annual differences between highest and lowest yielding varieties at UC alfalfa variety trials over the past 5–8 years (right). Assumptions: Hay price $130/ton, 20 lb/acre seeding rate, amortized over 4 years. Typically, less than 0.1 tons per acre production is necessary to justify a $2.00/lb increase in seed cost.

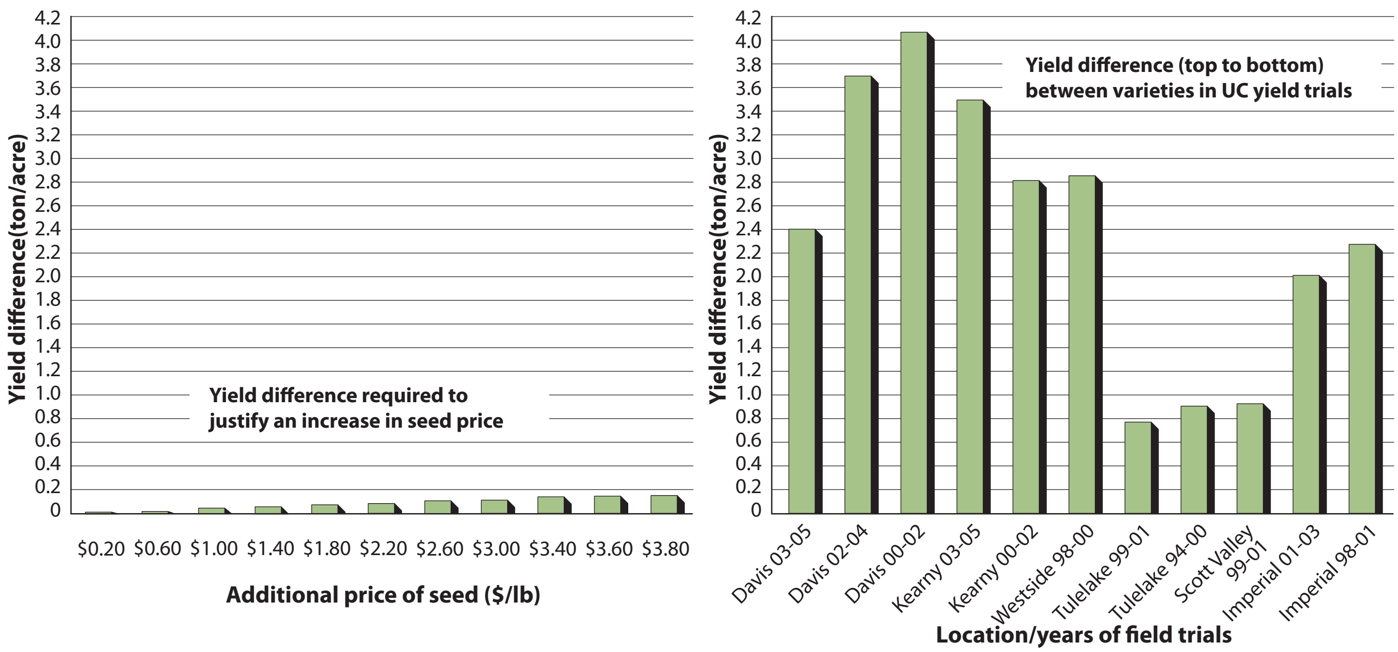
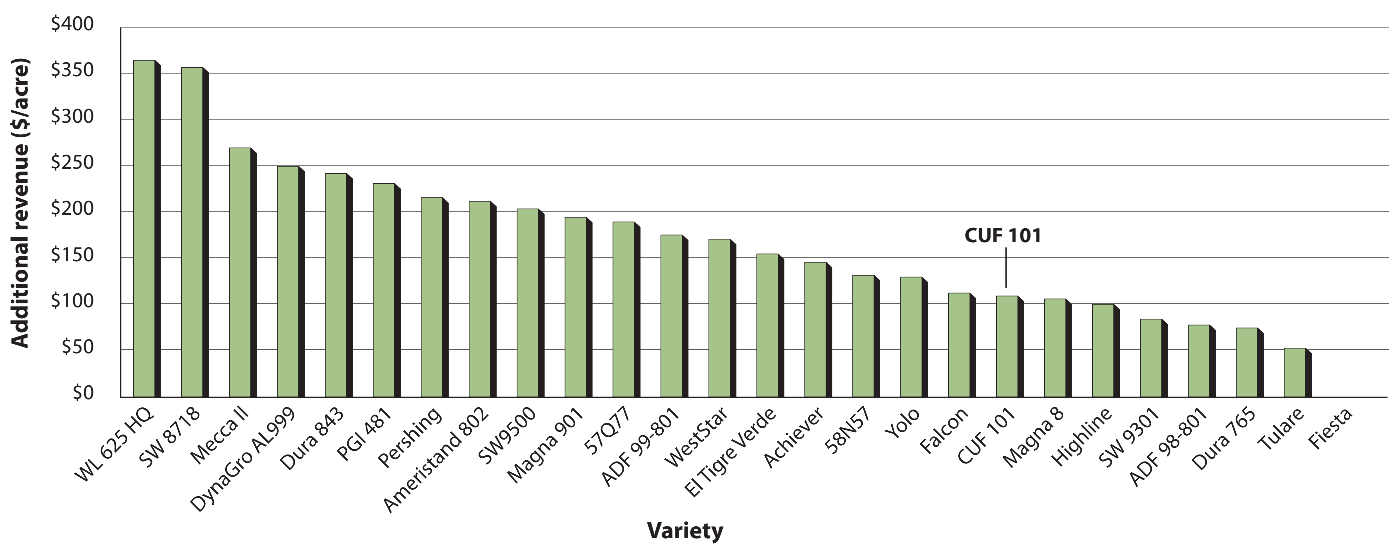


FIGURE 5.3

Potential average *additional* revenue per year resulting from variety choice based on a 3-year variety trial (03–05), Fresno, California. Assumptions: hay at $130/ton. Calculation is based on yield differences resulting from variety only.



seed price, is the primary economic factor for variety selection. In terms of profitability, the price of seed should be the last criterion by which varieties are chosen.

A Scientific Process for Choosing an Alfalfa Variety

A common mistake is to choose a variety based solely on price, habit, or the salesmanship of the dealer.

Many growers do not give variety selection the careful consideration it deserves. A common mistake is to choose a variety based solely on price, growth habit, or the salesmanship of the dealer. We suggest the following criteria for variety selection, based on the potential for profitability on the farm:

1. yield potential
2. fall dormancy
3. pest resistance
4. stand persistence
5. potential forage quality desired
6. added value of a specific biotech trait
7. on-farm tests of performance
8. price/availability/service

These criteria are in their approximate order of importance, but the significance of each factor will vary depending on a range of factors. These criteria obviously overlap. For example, pest resistance will impact stand persistence and yield. Fall dormancy impacts adaptation, yield potential, and forage quality, as well as stand persistence. However, each of these factors can be evaluated separately, and decisions can be made based on the overall goal of crop production. Finally, a grower should conduct on-farm strip trials to confirm the performance and value of a variety.

1. Choose a Group of High-Yielding Varieties from Yield Tests

Yield is an excellent indicator of the adaptation of a variety to an area and takes into account many other characteristics of the variety, including fall dormancy; insect, pest, and disease resistance; and stand persistence. Yield potential is typically the most important economic factor for growers and thus should be the first consideration for variety selection.

It is nearly impossible to determine the relative yield potential of different varieties without planting them side by side in replicated field trials. Tests done by universities provide unbiased measurements of relative forage yield. These trials typically compare varieties from many private and public sources. The yield of varieties planted side by side under uniform conditions is carefully measured and compared using statistically valid experimental designs. Data are published each year for many different locations in California and made available at http://alfalfa.ucdavis.edu and for other states at http://www.naaic.org/.

Should growers just choose the top line? Although it is tempting to simply select the top yielding variety, there are typically a group of varieties near the top of a trial that should be considered the high-yielding group. It is important to find unbiased data from trials conducted in areas that most nearly represent the soil and environment on your farm. Table 5.1 provides an example of a multiple-year yield summary for alfalfa varieties from trials conducted at the Kearney Research and Extension Center, Fresno County, California. Yield values followed by the same letter should be considered statistically equivalent (Table 5.1). This "high-yielding group" is often the top one-fourth to one-third of the varieties in the trial.

Seasonal trends. Some varieties yield more during the first cuttings of the year (spring), and less during the summer period, or visa versa (Fig. 5.4). Generally, the more dormant varieties tend to be relatively higher yielding in the spring than the nondormant varieties. These seasonal trends may be important to

TABLE 5.1

Example table showing yield results for released varieties from a multiyear trial conducted at Kearney Field Station, 2003–2005. This trial was planted in May, 2003, so the first-year yields are partial yields. Fall dormancy will frequently have an effect on yield, but there is a range of yields within dormancy groups as well. Generally, the top group A, B, and C should be considered the "top yielding" groups for this area. Up-to-date yield results are available from http://alfalfa.ucdavis.edu and other university Web sources.

Released Varieties	FD*	2003 Yield	2004 Yield	2005 Yield	Average		% of CUF101
		Dry t/a (rank)					
AL999	9	9.0 (1)	12.4(7)	11.9 (5)	11.1 (1)	A**	121.0
WL625HQ	9	8.3 (3)	12.8 (2)	12.3 (1)	11.1 (2)	A	120.9
Sequoia	9	8.0 (8)	12.6 (4)	12.1 (3)	10.9 (3)	A B	118.3
Magna995(DS995)	9	8.4 (2)	12.4 (9)	11.5 (7)	10.8 (5)	A B C D	117.0
Magna901	9	8.1 (6)	12.7 (3)	11.2 (13)	10.7 (6)	A B C D	115.9
CW1010(CW89064)	10	7.8 (13)	12.5 (5)	11.4 (9)	10.6 (8)	A B C D E F	114.8
Meccalll	9	78 (10)	12.4 (10)	11.3 (12)	10.5 (10)	A B C D E F G	114.1
Dura843	8	7.5 (28)	12.1 (11)	11.3 (10)	10.3 (12)	A B C D E F G H	111.9
Westan	8	7.6 (25)	12.0 (13)	10.7 (19)	10.1 (15)	B C D E F G H I	109.6
58N57	8	7.6 (24)	11.6 (17)	10.8 (17)	10.0 (17)	C D E F G H I K L	108.7
Westar	8	8.0 (9)	116 (21)	10.4 (25)	10.0 (18)	C D E F G H I K L M	108.5
Salado	9	8.2 (4)	11.6 (18)	10.1 (30)	10.0 (19)	C D E F G H I K L M	108.4
WL530HQ	8	7.7 (16)	11.2 (26)	10.9 (14)	10.0 (21)	D E F G H I K L M	108.1
CW801 (CW58073)	8	7.7 (18)	11.0 (30)	10.7 (20)	9.8 (22)	E F G H I K L M N	106.6
Magna801fq	8	7.7 (20)	10.9 (32)	10.8 (18)	9.8 (24)	E F G H I K L M N	106.3
59N49	9	7.6 (26)	11.6 (19)	10.2 (29)	9.8 (25)	E F G H I K L M N	106.2
Magna788(DS788)	8	7.6 (22)	11.1 (29)	10.6 (22)	9.8 (26)	E F G H I K L M N	106.2
Pershing	8	78 (11)	108 (35)	10.6 (23)	9.7 (27)	F G H I K L M N	105.6
SW100(SW101)	10	7.7 (21)	11.4 (23)	10.0 (33)	9.7 (28)	G H I K L M N	105.1
CW704	7	7.4 (30)	11.4 (24)	10.3 (27)	9.7 (29)	G H I K L M N	105.1
CW907	9	7.3 (32)	11.1 (28)	10.5 (24)	9.6 (30)	H I K L M N	104.6
ArtesiaSunrise	7	78 (15)	11.2 (27)	9.7 (37)	9.5 (31)	H I K L M N	103.7
FG03-01	8	7.8 (12)	10.9 (34)	9.5 (38)	9.4 (33)	I K L M N	102.0
C-241	5	7.5 (27)	10.4 (38)	10.2 (28)	9.4 (34)	I K L M N	101.8
CUF101	9	7.2 (35)	116 (20)	8.9 (39)	9.2 (36)	K L M N	100.0
Dura765	7	6.8 (40)	10.9 (33)	9.8 (36)	9.2 (37)	L M N	99.5
DelRio	6	7.0 (38)	10.5 (37)	9.9 (35)	9.1 (38)	M N	99.3
WL325HQ	3	7.2 (36)	7.6 (40)	7.9 (40)	7.6 (40)	O	82.1

	2003	2004	2005	Average
Mean	7.65	11.49	10.68	9.94
CV	7.10	10.30	5.90	7.80
LSD (05)	0.76	1.66	0.89	0.85

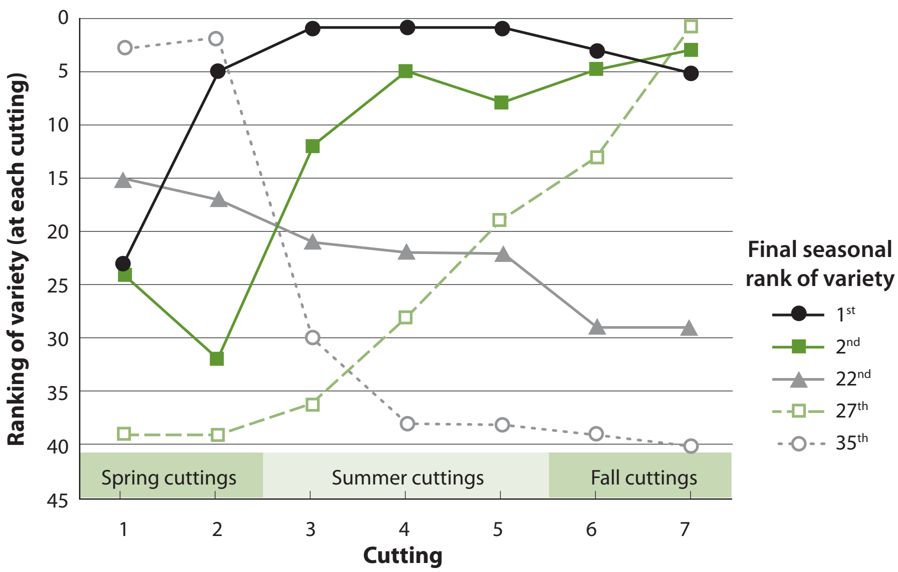
Note: Variety × year interaction is significant. Trial seeded at 25 Ib/acre viable seed on Hanford fine sandy loam soil at UC Kearney Agriculture Center, Parlier, CA.

*FD = Fall dormancy rating reported by seed companies.

**Entries followed by the same letter are not significantly different at the 5% level of probability.

FIGURE 5.4

Seasonal yield pattern (by rank) of alfalfa varieties, example from Davis trial, 2005—harvest is April through October. Some varieties start off strong but yields decline in late summer (variety with final rank of 35), whereas other varieties may start off moderately and develop higher yields later (varieties ranked 1 and 2). Variety ranked 27 produces poorly in the spring, but is high ranking in the fall harvests. Other varieties are more consistent throughout the season (variety rank 22).

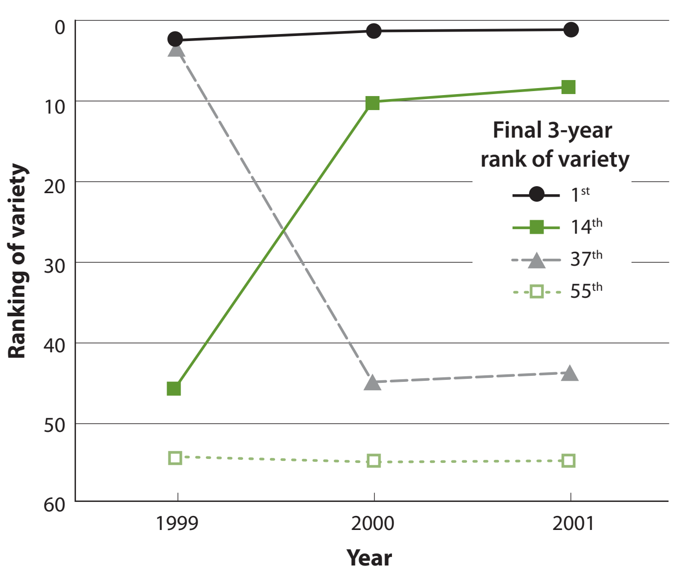


growers who seek high yields during spring when quality tends to be higher, or during summer when hay curing is easier. However, for most growers, high average season-long yields are likely to be more important than seasonal trends.

Importance of multiple-year trials. Because alfalfa is a perennial, it is important to take into consideration data from a number of years to assess yield potential. Never rely solely on the first year of data from a newly planted trial. Some varieties have only moderate yields in the first year but perform much better in the second and subsequent production years to become top-yielding lines (Fig. 5.5). Other varieties may be very high yielding the first year, but fail miserably by the third year of production. Therefore, yield performance over the entire desired stand life is the most important criterion, not just yield for a single season. Generally, we have found that yield trends from a 3-year trial in Mediterranean and desert climates are likely to be good indicators for subsequent years of production.

FIGURE 5.5

Over-the-years yield pattern of alfalfa varieties, data from West Side Field Station, Fresno County, California. Some varieties are consistently high or low yielding (varieties with rank 1 and 55, respectively). Others show trends over the years (varieties ranked 14 and 37). Therefore, do not use single-year observations to select alfalfa varieties.



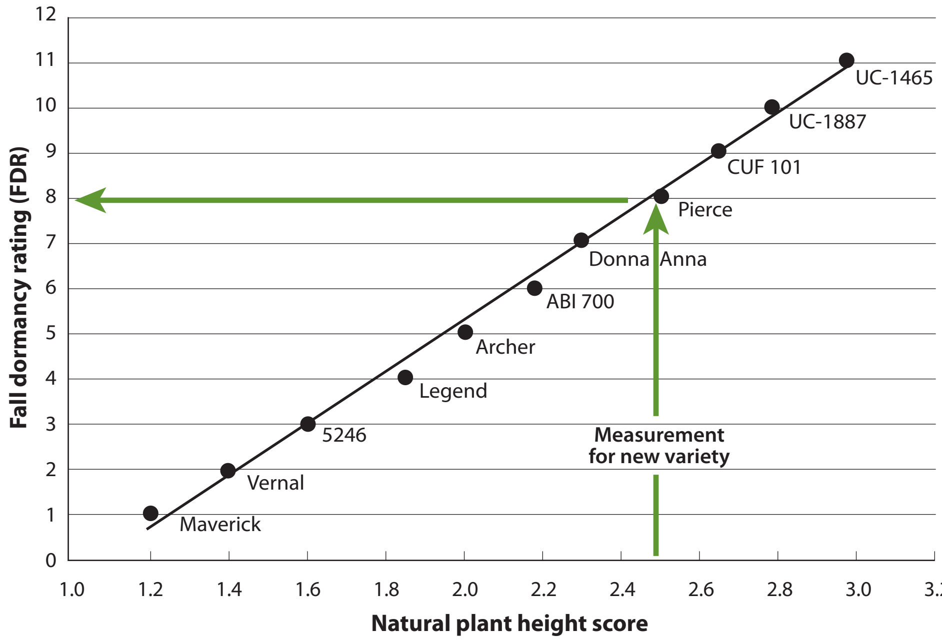
2. Select an Appropriate Fall Dormancy Rating

Fall dormancy (FD) is one of the most important traits of an alfalfa variety, affecting adaptation, yield, persistence, and quality. Fall dormancy is described and quantified as the degree of growth (plant height) during the fall. Fall dormancy is under genetic control and is a manifestation of the plant's physiological response to cool temperatures and reduced day length. Varieties are rated for fall dormancy by seed companies and independent tests, such as those conducted by UC Davis scientists.

Varieties with fall dormancy ratings (FD) from 1 to 4 are considered dormant, 5 to 7 semi-dormant, and 8 to 11 nondormant. New varieties are compared with standard check varieties to determine their ratings (Fig. 5.6). Nondormant varieties are dramatically taller in the fall and exhibit greater fall and winter growth than dormant varieties grown in a Mediterranean climate (Fig. 5.7). Nondormant varieties may exhibit height differences during other parts of the year as well, but not as pronounced.

FIGURE 5.6

Fall Dormancy of standard check varieties used to rate fall dormancy of alfalfa varieties. In this example, a new variety is measured to be closest in natural plant height under fall conditions to the check variety "Pierce" and thus receives a rating of 8.0.



Environment, experience, and the objectives of the grower determine the optimum FD choice. Varieties with higher FD tend to be higher yielding, but this is not always the case. One approach is to choose the highest FD that can survive in a region because those varieties with higher FD tend to be higher yielding. However, quality and long-term stand persistence are also important considerations. Varieties with a higher FD tend to be higher yielding in Mediterranean and desert zones, but may be lower quality and less persistent. Generally, in the northern part of the San Joaquin and Sacramento Valleys (6–7 cut system) semi-dormant and nondormant varieties with FDs of 6–8 are higher yielding, but growers frequently plant FD 3–4 varieties because of their better persistence on heavy soils and higher quality. Varieties with FDs of 7–9 tend to top yield trials in the lower San Joaquin Valley, whereas in the low deserts of the Imperial Valley and Palo Verde Valley, FDs of 8–11 are most commonly grown.

In contrast, dormant or semi-dormant varieties (FD 2–5) are most appropriate for areas with cold winter conditions, such as

FIGURE 5.7

Differences in fall dormancy (FD) in December, Davis, California. The fall dormancy trait of alfalfa is best expressed in fall and winter, but differences in height and regrowth rate can also be seen during spring and summer months.

Intermountain valleys. In these areas, consideration of winter survival characteristics is important (see University of Wisconsin Web site: http://www.uwex.edu/ces/crops/uwforage/alfalfa.htm for uniform trials; and from Tulelake: http://alfalfa.ucdavis.edu). Stand loss in Mediterranean and arid zones is most common in summer and does not seem to be related to winter hardiness.

Fall dormancy is also strongly associated with forage quality. In some regions, growers elect to plant lower FD varieties than those that would produce the highest yield, with the objective of achieving higher-quality forage. This is covered in more detail below.

3. Choose a Variety with the Best Insect and Disease Resistance

Alfalfa has benefited from decades of plant breeding, improving both yield and pest resistance. The first success was the incorporation of bacterial wilt resistance in the 1940s, followed in the 1950s through 1970s with multiple pest resistance to major insects and other diseases, a process that continues today. Recently, varieties with resistance to potato leaf hopper and silverleaf whitefly have been developed, adding these traits to those of resistance to aphids, nematodes, and root diseases developed over the past 40 years. Detailed pest resistance ratings of current varieties are given at the National Alfalfa and Forage Alliance Web site (http://www.alfalfa.org).

It is important to determine the most significant diseases, nematodes, and insect pests in your region to decide the best pest-resistance package.

It is important to determine the most significant diseases, nematodes, and insect pests in your region to decide what is needed as a pest-resistance package. Recommendations developed from experience over a long period are provided in Table 5.2 to aid in judging the importance of different pests for your region.

Different pests are important for different regions and for different soil types. For example, verticillium wilt is more important in the Central and Northern Coastal Regions, High Desert, and Intermountain area, but is not seen in the Low Desert. Phytophthora resistance is especially important on heavy soils or in high-rainfall areas. Resistance to pea aphid, blue alfalfa aphid, and spotted alfalfa aphid is critical for the Low Desert and San Joaquin Valley Regions (Table 5.2).

The importance of pest resistance of alfalfa varieties to an integrated pest management program (IPM) cannot be overemphasized. Diseases or nematodes are seldom controlled effectively by chemical sprays, and variety selection is often the *only* cost-effective method available. Figure 5.8 illustrates the value of variety resistance for pea aphid and for Phytophthora root rot.

Resistance to pests is not absolute. Due to the nature of alfalfa varieties as populations, some plants will remain susceptible even within a highly resistant line. An alfalfa variety that is classified as highly resistant (HR) to a given insect or disease has by definition greater than 50 percent of the plants exhibiting resistance, resistant varieties (R) are those with 35–50 percent of the plants exhibiting resistance, and so on (see below). In some cases, the level of resistance can be influenced by climatic conditions. Temperatures less than 60°F (15°C) reduce the resistance to pea aphid, blue alfalfa aphid, and spotted alfalfa aphid. This is especially important with pea and blue alfalfa aphids, which are cool-weather aphids. Cooler than normal spring temperatures may result in a breakdown of resistance and an increase in

Pest resistance ratings:		% of Plants resistant
HR	Highly resistant	>50
R	Resistant	35–50
MR	Moderately resistant	20–35
LR	Little resistance	5–20
S	Susceptible	<5

NOTE: Pest resistance is determined independently in greenhouse seedling tests. See http://www.naaic.org/ for description of tests.

TABLE 5.2

Suggested fall dormancy ratings and minimum pest resistance ratings for different California climatic zones

Zone	FD	BW	VW	FW	PRR	SAA	PA	BAA	SN	SRKN	NRKN
Intermountain	2-4	R	R	HR	R	S	R	MR	R	R	R
Sacramento Valley	4-8	MR	R	HR	HR	R	HR	HR	HR	R	R
San Joaquin Valley	7-9	MR	R	HR	HR	HR	HR	HR	HR	HR	HR
Coastal	4-8	MR	HR	HR	HR	MR	HR	HR	HR	HR	HR
High Desert	4-8	MR	HR	HR	HR	R	R	R	R	HR	HR
Low Desert	8-11	S	S	HR	HR	HR	HR	HR	HR	HR	HR

FD = fall dormancy; BW = bacterial wilt; VW = verticillium wilt; FW = fusarium wilt; PRR = phytophthora root rot; SAA = spotted alfalfa aphid; PA = pea aphid; BAA = blue alfalfa aphid; SN = stem nematode; SRKN = southern root knot nematode; NRKN = northern root knot nematode.

HR = highly resistant; R = resistant; MR = moderately resistant; S = susceptible

FIGURE 5.8

Crop vigor and stand can be affected by disease and insect resistance. Photo A shows varieties resistant to (left) and susceptible to (right) pea aphid. Photo B shows varieties resistant to (left) and susceptible to (right) Phytophthora root rot (photo courtesy, Oklahoma State University). Photo C shows selection for Silverleaf Whitefly resistance (UC Impalo WF) in the Imperial Valley of California.

aphid populations, even in so-called resistant varieties.

Resistance to pests should be considered an insurance policy that is an important benefit of improved varieties. Even if a pest is not present each year, resistance may become valuable over the life span of an alfalfa stand. For example, growers in the Sacramento Valley had neglected to select varieties resistant to stem nematode since it hadn't been a problem for years. In 2002–2003, many fields were suddenly infested with stem nematode, leaving many growers wishing they had selected resistant varieties, which is our only cost-effective measure for this pest.

4. Consider Stand Persistence

Most growers in the Central Valley and Imperial Valley of California keep their stands in for 3–4 years before rotating to another crop. Stand loss in these regions is exacerbated by frequent harvests, traffic, summer heat, scald, winter flooding, cold winter temperatures, soil compaction, and soil-borne diseases. Stand loss provides incentives for growers to rotate quickly to another crop rather than keeping stands for longer periods. Although keeping an alfalfa stand in for longer than 4 years may be economically beneficial in some cases, this is not the case if yields are significantly lower in the third, fourth, and subsequent years. This is frequently the case with nondormant varieties.

Generally, more dormant varieties tend to have better stand persistence than do nondormant varieties, if within their areas of adaptation. However, these varieties also tend to have lower yields in the Mediterranean and desert zones. In the northern Central Valley, varieties with FDs of 8–11 frequently have poor persistence, whereas varieties with FDs of 5–7 last longer. Further south, the yield penalty of the lower FD varieties becomes much higher, and thus these varieties are not recommended. The objectives of the individual grower, whether yield, persistence, or quality, is more important, should be considered to determine which fall dormancy is best. Soils prone to flooding may require more dormant lines, which may tolerate flooded conditions better than nondormant lines.

Diseases, particularly Phytophthora root rot, can be very destructive to alfalfa stands, limiting stand life. Choice of varieties with high resistance (HR) to Phytophthora root rot and to nematodes is an important method for improving stand life.

5. Choosing Varieties to Achieve High Quality

Many agronomic factors affect forage quality—one of which is variety selection. Although varieties may differ in forage quality, agronomic practices, such as cutting schedule and weed control, influence quality to a greater degree than does variety.

The potential forage quality of an alfalfa variety should not be considered without considering yield. In our trials, higher-quality varieties have almost always been lower yielding. There is a yield–quality tradeoff with varieties, just as there is with cutting schedules (see Chapter 13, "Harvest Strategies for Alfalfa"). Therefore, we recommend that growers balance yield and quality factors and consider the importance of both.

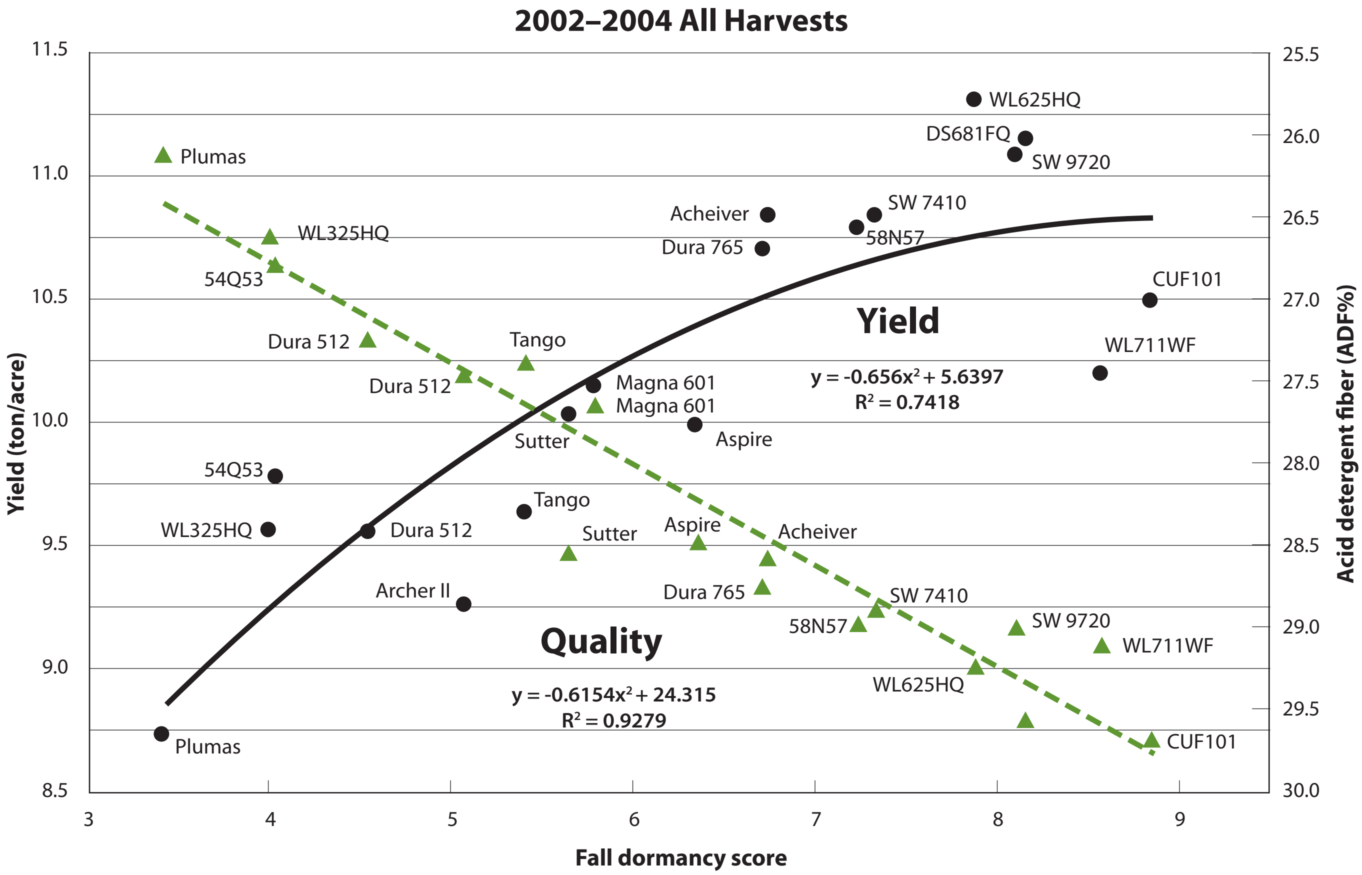
Although varieties may differ in forage quality, agronomic practices, such as cutting schedule and weed control, influence quality to a greater degree than does variety.

Fall dormancy has a profound effect on forage quality. At UC Davis, it was found that each unit decrease in FD caused an average of 0.6 percentage unit decrease in ADF, a similar decrease in NDF values, and a 0.6 percent increase in crude protein, averaged across 3 years and three cutting schedules, all harvests (Fig. 5.9). However, the yields of the more dormant varieties were much lower, an average of 0.66 tons/acre (1.5 Mg/ha) reduction per unit of FD, than the nondormant varieties (Fig. 5.9).

Economics of the yield–quality tradeoff. To choose a variety for quality, one must be prepared to accept the yield loss that typically results from such a choice. Although it is tempting to think that variety selection is a magic bullet to deliver a higher-quality product, it is more often a compromise between yield, quality, and stand persistence. This can be managed to some degree by comparing the yield differences between varieties with their probable increased value from higher quality (Table 5.3). For example, if two varieties differ by 2 tons per acre per year (4.48 Mg/ha), it would be necessary to improve the price per ton of the lower yielding variety by 33 percent at an 8 ton (7.25 Mg) yield level (Table 5.3). If there are forage quality data to give a grower confidence that this will occur, choose the higher-quality (but lower-yielding) variety. If not, select the higher-yielding variety. Examples of yield–quality tradeoff result-

FIGURE 5.9

Fall dormancy effects on ADF and yield of alfalfa varieties, Davis, California (average of 3 years, three cutting schedules, and three replications, all harvests each year).



ing from the FD of a variety are illustrated in Figure 5.9.

6. Consider Biotech Traits

In 2005, the first biotech trait in alfalfa was commercialized—Roundup Ready (RR) alfalfa. Several other biotech traits will likely be introduced in the future, traits that may contribute to improved feeding value, pest resistance, or other attributes. The introduction of biotech traits into alfalfa expands the scope of variety selection beyond the factors of yield, quality, persistence, and pest resistance. However, those factors are still of primary importance for variety selection.

Selection of RR alfalfa varieties is fundamentally no different than selection of conventional alfalfa varieties, with the exception of the additional dimensions of weed management and market acceptance of a genetically engineered (GE) crop. RR varieties should be chosen for their yield potential, pest resistance, stand persistence, and quality—just like conventional varieties. Under most circumstances, it is not usually cost-effective to choose a lower-yielding RR variety just to obtain the Roundup resistance trait—this may result in significantly lower returns because of lower yields.

The value and advantages of the RR (or other biotech) trait must be compared economically with the additional costs (or other negative features) of that trait. Purchase of RR alfalfa is a purchase of a weed-control system, not just a variety, and should be thought of in relationship to that system.

TABLE. 5.3

Minimum percentage price improvement required to justify a yield decline due to variety choice or cutting schedule on an annual or a per-cutting basis

Starting Yield t/a	Reduction in Yield (Per Cutting Basis, t/a) Minimum Price Improvement Required									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.4	33.3%	100.0%	300.0%							
0.6	20.0%	50.0%	100.0%	200.0%	500.0%					
0.8	14.3%	33.3%	60.0%	100.0%	166.7%	300.0%	700.0%			
1	11.1 %	25.0%	42.9%	66.7%	100.0%	150.0%	233.3%	400.0%	900.0%	
1.2	9.1%	20.0%	33.3%	50.0%	71.4%	100.0%	140.0%	200.0%	300.0%	500.0%
1.4	7.7%	16.7%	27.3%	40.0%	55.6%	75.0%	100.0%	133.3%	180.0%	250.0%
1.6	6.7%	14.3%	23.1%	33.3%	45.5%	60.0%	77.8%	100.0%	128.6%	166.7%
1.8	5.9%	12.5%	20.0%	28.6%	38.5%	50.0%	63.6%	80.0%	100.0%	125.0%
2	5.3%	11.1 %	17.6%	25.0%	33.3%	42.9%	53.8%	66.7%	81.8%	100.0%
2.2	4.8%	10.0%	15.8%	22.2%	29.4%	37.5%	46.7%	57.1%	69.2%	83.3%
2.4	4.3%	9.1%	14.3%	20.0%	26.3%	33.3%	41.2%	50.0%	60.0%	71.4%
2.6	4.0%	8.3%	13.0%	18.2%	23.8%	30.0%	36.8%	44.4%	52.9%	62.5%
2.8	3.7%	7.7%	12.0%	16.7%	21.7%	27.3%	33.3%	40.0%	47.4%	55.6%
3	3.4%	7.1%	11.1 %	15.4%	20.0%	25.0%	30.4%	36.4%	42.9%	50.0%

Starting Yield t/a	Reduction in Yield (Annual Basis, t/a) Minimum Price Improvement Required									
	0.2	0.4	0.6	0.8	1.0	1.5	2.0	2.5	3.0	3.5
4	5.3%	11.1 %	17.6%	25.0%	33.3%	60.0%	100.0%	166.7%	300.0%	700.0%
5	4.2%	8.7%	13.6%	19.0%	25.0%	42.9%	66.7%	100.0%	150.0%	233.3%
6	3.4%	7.1%	11.1 %	15.4%	20.0%	33.3%	50.0%	71.4%	100.0%	140.0%
7	2.9%	6.1%	9.4%	12.9%	16.7%	27.3%	40.0%	55.6%	75.0%	100.0%
8	2.6%	5.3%	8.1%	11.1 %	14.3%	23.1%	33.3%	45.5%	60.0%	77.8%
9	2.3%	4.7%	7.1%	9.8%	12.5%	20.0%	28.6%	38.5%	50.0%	63.6%
10	2.0%	4.2%	6.4%	8.7%	11.1 %	17.6%	25.0%	33.3%	42.9%	53.8%
11	1.9%	3.8%	5.8%	7.8%	10.0%	15.8%	22.2%	29.4%	37.5%	46.7%
12	1.7%	3.4%	5.3%	7.1%	9.1%	14.3%	20.0%	26.3%	33.3%	41.2%
13	1.6%	3.2%	4.8%	6.6%	8.3%	13.0%	18.2%	23.8%	30.0%	36.8%
14	1.4%	2.9%	4.5%	6.1%	7.7%	12.0%	16.7%	21.7%	27.3%	33.3%

How to use this table: This table can be used to estimate short-term and long-term tradeoffs between yield and quality. For example if a "Late" cutting schedule would normally yield 1.4 tons/acre, and a grower wants to cut early for quality, he should require a minimum of 27.3% improvement in price (top part of table) if his yield is reduced by 0.3 t/a by that earlier cutting strategy. If a higher yielding variety has an 8 ton/acre yield potential, a variety that yields 1.5 tons/acre less should return a minimum of 23.1% greater price through improved quality to justify choosing that variety.

In addition to cost issues, growers should consider the degree of success of their current weed-control strategies and market considerations. Most experts believe that the majority of alfalfa markets will not be sensitive to the RR trait. However, there are some markets that will not accept RR alfalfa or varieties with other biotech traits. Certification for organic alfalfa requires that no biotech traits (and no herbicides) be used, which disallows use of RR alfalfa varieties. Exporters have generally required that alfalfa for export be non-biotech. A full discussion of the RR trait and the methods to assure coexistence of biotech and nonbiotech traits is provided elsewhere (see Van Dynze et al., 2004, and Putnam 2006).

7. Conduct On-Farm Strip Trials

On-farm strip trials are valuable to confirm small plot experimental data and to make sure a particular variety will perform well on your farm. With the many soil types and microclimates in California, it is impossible to conduct university or company trials under all the possible conditions. You may want to consult with your Cooperative Extension Farm Advisor before conducting strip trials. It is important to replicate strips over your field (not plant separate fields or split fields in half) because varieties must be observed on the same soil type and under the same management. Plots should be replicated and randomized, if possible. For example, if you wanted to test four varieties, plant randomized checks or strips of each variety. Three replications (each variety planted in three separate strips) should normally be sufficient. Sometimes differences between varieties can be detected by counting bales, but bale weight and moisture are often too variable for precise estimates of yield using this method. Small-plot trials tend to be more accurate, especially if the expected differences are small. Seed companies are also usually very helpful in setting up strip trials on farms. In addition to yield, on-farm strip trials are very useful to assess differences in stand persistence, pest resistance, and traffic resistance.

8. Compare Service, Availability, and Price

The last (and probably least important) aspect of variety selection is price of seed, along with aspects such as service by the seed company. Availability is also an obvious limitation—seed companies change varieties frequently, which is frustrating to growers who wish to have longer-term tests. Service by the seed company is important, since seed salesmen and consultants can provide other advice in addition to variety selection. Do not purchase seed based on habit or what the local seed dealers happen to have on hand. The economics of alfalfa production show that performance, not price, is the key economic factor for variety choice (see Figs. 5.2–5.3), and gains (or losses) of hundreds of dollars per acre (or hectare) may ride on the choice of variety. This becomes more critical as biotech traits are introduced, increasing the importance of performance vs. the price of the seed.

Summary

Growers have benefited from decades of plant breeding that have produced hundreds of alfalfa varieties from which to choose. Variety choice can be quite important economically, returning hundreds of dollars per acre (or hectare) with a small investment in time and attention. Performance is much more important economically than seed cost, as improved seed can provide economic returns manyfold times the additional cost. A systematic approach to variety selection, which takes into account yield potential, fall dormancy, pest resistance, stand persistence, forage quality, and biotech traits will enable growers to find the best possible varieties for their ranch.

Additional Reading

American Alfalfa and Forage Alliance. Variety Leaflet. Current listing of varieties marketed in the U.S., with fall dormancy ratings and pest resistance ratings. http://www.alfalfa.org/.

North American Alfalfa Improvement Council. Listing of variety releases, nationwide variety testing sites, and standardized evaluation methods. http://www.naaic.org/.

Putnam, D.H. 2006. Methods to enable co-existence of diverse production systems involving genetically-engineered alfalfa. University of California Division of Agriculture and Natural Resources, Oakland. http://alfalfa.ucdavis.edu.

Putnam, D.H., S.B. Orloff, and L.R. Teuber. 2005. Varieties and cutting schedules affect the yield quality tradeoff. Proceedings, California Alfalfa and Forage Symposium, December 12–15. UC Cooperative Extension. http://alfalfa.ucdavis.edu.

University of California Alfalfa Workgroup Web site Variety Trial Reports. Includes current data, and a searchable database of more than 30 years of UC variety trials. http://alfalfa.ucdavis.edu/+producing/variety.html.

Van Dynze, A., D.H. Putnam, S. Orloff, T. Lanini, M. Canevari, R. Vargas, K. Hembree, S. Mueller, L. Teuber. 2004. Roundup Ready alfalfa: an emerging technology. University of California Division of Agriculture and Natural Resources, Oakland. http://anrcatalog.ucdavis.edu.

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