VARIETY SELECTION – CHOOSING THE BEST FOR YOUR FIELD

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ABSTRACT

Yield performance, fall dormancy, and pest resistance are the three most important factors to consider when choosing an alfalfa variety. High yielding varieties are key to profitable operations but dormancy determines the adaptation of a variety to different climates. Choosing a variety in the wrong dormancy class for a particular region may result in excessive stand loss in the first winter or lower production potential through the growing season. Results of variety tests, especially those conducted by unbiased sources such as universities or grower associations, provide information on the yield potential of varieties and their adaptation to climate regions. Growers should be aware of any significant insect or disease problems in their production area or in a particular field. The National Alfalfa and Forage Alliance (NAFA) Variety Leaflet provides information about the resistance levels of varieties to many important pest and diseases. Forage quality information is more difficult to obtain from field trials, in part because of cost for analyses. In practically all cases there are several varieties that would do well in any given location. Growers should not rely on just one variety if planting numerous fields, and may even want to plant their own strip trials to help with decisions in future years.

Key Words: alfalfa variety testing, *Medicago sativa*, cultivar selection, yield, dormancy, pest resistance, stand persistence, quality

INTRODUCTION

Choosing which alfalfa variety or cultivar to plant has major implications for a grower. Contained within the seed are the genetics that determine the potential maximum yield of that variety. Most growers intend to keep their alfalfa stands for at least 3 years (and in many cases for longer) so the choice of variety is one that they must live with for the length of the stand. There are over 300 alfalfa varieties for sale in the US according to the 2013 edition of the National Alfalfa &Forage Alliance's publication, "Winter Survival, Fall Dormancy & Pest Resistance Ratings for Alfalfa Varieties." With so many from which to choose, it is well worth the time to carefully evaluate which of the many varieties will do best in a particular field.

FACTORS TO CONSIDER

Yield. The first factor to consider is the yield potential for a variety in a given location because yield is the primary driver for profitability. Although there are years when the price differential between *Supreme*, *Good* and *Fair* alfalfa hay is so large that it might pay to sacrifice yield for

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quality, those times are relatively few. In the vast majority of years, a grower makes more money choosing the highest yielding varieties than choosing a variety that would yield significantly less but perhaps produce higher quality hay.

Dormancy. It is difficult to discuss yield potential without discussing fall dormancy, which is an excellent indicator of how well a variety is adapted to a geographical location and effects yield, quality, and persistence. Fall dormancy relates to the degree that photoperiod (day length) influences alfalfa growth, particularly in the fall after the vernal equinox when the hours of daylight become less than the hours of darkness. This change to short days affects alfalfa growth to varying degrees depending on the dormancy characteristics of a variety. Very non-dormant varieties will grow regardless of daylength as long as temperatures are favorable, whereas the growth of dormant varieties slows significantly in fall even when temperatures remain warm. Varieties are rated based on their fall growth relative to known standards. The lower the dormancy rating, the more dormant the variety is. For example, a variety with a Fall Dormancy rating of 3 is more dormant than a variety classified as Fall Dormancy 4. Varieties with fall dormancies of 1-4 are generally referred to as dormant, those classified as fall dormancies of 5-7 are called semi-dormant, and varieties of dormancies 8-11 are referred to as non-dormant varieties. There is a strong correlation between dormancy and winter hardiness. However, that relationship is not as strong as it once was and alfalfa breeders have made significant progress developing less dormant varieties with improved winter hardiness. Besides differences in fall growth and winter survival, varieties with less dormancy will tend to regrow faster after cutting than more dormant varieties. With these characteristics, it is easy to understand that the more dormant varieties are grown in climates with cold winters and relatively short growing seasons while less dormant varieties are better adapted to areas with mild winters and longer growing seasons. In any one location however, there is often a spread of 1 to 3 dormancy classes that can be grown successfully.

While generalizations can be made regarding the dormancy classes that would be adapted to a growing area, yield trials comparing varieties are the most useful tools for growers to evaluate variety performance. Growers should have the most confidence in replicated trials run by universities, hay grower associations, or other unbiased groups. Replication provides the opportunity to statistically analyze the data, estimate the amount of variability in a trial and determine with confidence that a yield difference between two varieties is a real difference rather than just something that occurred by chance.

Interpreting Variety Trial Reports. University of California alfalfa variety trials are conducted in the major alfalfa growing regions of the state with ordinarily two locations in the northern Intermountain area, one in the Sacramento Valley, two in the San Joaquin Valley and two in the low desert regions of the state. These replicated trials are conducted for multiple years with the results published on-line. They are available at the UC Alfalfa Workgroup website: www.alfalfa.ucdavis.edu. Interpreting reports from these trials can be daunting at first glance but it is worth the effort to study and understand the information.

A partial report from the 2009 - 2011 UC trial conducted at Davis is shown in Table 1.The varieties that are commercially available are listed first (experimental varieties are also included in these trials and their results are reported in a section beneath the commercial varieties but for

the sake of space are not included in this table). The second column lists the Fall Dormancy (FD) of the varieties as reported by the seed companies. The fact that the top 3 varieties represent 3 different Fall Dormancy classes (FD 6, 7, & 8) is a good example that Fall Dormancy by itself is not a reliable predictor of the best variety for a location.

Table 1.Yield results in dry tons/acre for the top 10 yielding varieties and the standard (CUF 101) from the 2009-2011 UC trial conducted at Davis, Yolo County, CA.

Column 1 Released Varieties	*Col. 2* FD	*Col. 3* 2009 Yield	*Col. 4* 2010 Yield	*Col. 5* 2011 Yield	*Col. 6* Average	*Col. 7*		*Col. 8*% of CUF 101
HybriForce 620	6	13.0 (2)	10.5 (1)	11.4 (1)	11.6 (1)	A		136.6
Magna 801 FQ	8	13.1 (1)	9.8 (13)	10.4 (7)	11.1 (4)	ABC		130.4
PGI 709	7	12.5 (5)	10.1 (8)	10.4 (6)	11.0 (5)	ABCD		129.2
HybriForce 709	8	12.4 (7)	10.0 (9)	10.4 (5)	10.9 (6)	ABCDE		128.7
Conquistador	8	12.1 (19)	10.2 (4)	10.2 (9)	10.8 (7)	ABCDEF		127.4
58R51 RR	8	12.1 (16)	10.3 (3)	9.8 (25)	10.7 (9)	BCDEFG		126.3
Integra 8800	8	12.0 (20)	12.0 (20)	10.2 (5)	10.0 (17)	BCDEFG		126.2
Arriba II	7	12.3 (9)	9.4 (22)	10.1 (14)	10.6 (12)	BCDEFGH		124.6
WL 530 HQ	8	12.7 (3)	9.8 (15)	9.3 (37)	10.6 (13)	BCDEFGH		124.4
GrandSlam	8	11.3 (26)	10.1 (6)	10.2 (11)	10.5 (14)	BCDEFGH		123.5
HybriForce 700	7	11.1 (31)	10.1 (7)	10.2 (10)	10.5 916)	BCDEFGHI		123.1
Pacifico	9	12.1 (18)	9.3 (23)	9.9 (17)	10.5 (17)	BCDEFGHI		122.9
PGI 608	6	12.2 (13)	8.9 (37)	10.3 (8)	10.4 (18)	BCDEFGHI		
56S82	6	12.3 (11)	9.3 (25)	9.4 (34)	10.3 (21)	BCDEFGHIJ		
CUF 101	9	9.5 (44)	8.8 (39)	7.2 (45)	8.5 (44)		M	100.0
MEAN		11.47	9.38	9.73	10.19			
CV		9.1	8.1	9.2	6.8			
LSD(0.1)		1.24	0.91	1.07	0.82			

The next 4 columns list the yields (dry tons/acre) for each of the three years in the trial and the average of the three years. The numbers in parentheses adjacent to the yield value indicate the ranking of the variety in that year. This is a rather unique example because the top yielding variety over the three years of the trial (column 6) ranked either first or second for each year of the trial. It is much more common to see significant changes in rank from year to year and one should never base a decision on what to plant using just one year of data. The more years in a trial and the more trials, the more reliable the information is.

Now is a good time to look near the bottom of the page where the Mean, CV and LSD (0.1) are listed. The *Mean* is the average of all the varieties (commercial and experimental) in the trial for each year. CV stands for *Coefficient of Variation* and provides information on how much uncontrolled variation there was in the trial. This can be thought of as background "noise." In general, the lower the CV the better. For alfalfa trials, a CV of 12% or lower is acceptable. LSD (0.1) stands for *Least Significant Difference* and indicates how much difference there has to be in the yield of one variety compared to another for us to say with 90% certainty that there is a real difference between the two varieties. Or conversely, we are willing to say that there is a 10% probability (a probability of 0.1) that the difference between the two varieties was due just to chance and they aren't really different.

All the letters (column 7) to the right of the 3 year average are determined from the LSD value from the multiple year average (column 7). If 2 varieties have the same letter next to them, then the difference between their yields is not larger than the LSD value and they cannot be considered different from each other. So in the example in Table 1, the top 5 varieties cannot be considered different from each other (they are each followed by the letter A). It is important to look at these letters indicating significant differences because when choosing a variety one should look at all the varieties that are in the top group – not just the one variety at the top of the list! In fact with the data in Table 1, varieties followed by A's, B's and C's would be hard to differentiate (the 2nd through the 5th listed varieties).

The last column on the right compares the yields of the varieties in the trial to a standard variety. The standard variety's yield is set at 100% and each variety's yield is calculated as a percent of the standard. In the example shown, the standard is CUF 101, which was developed in the 1970's. The best varieties in the trial produced about a third more tonnage, or 130% of CUF 101. It is a testament to breeding efforts that newer varieties produce so much more than a variety that "set the bar" for many years.

It is important to look at the variety trials conducted in the location most similar to the location of the field to be planted. Growers in the Sacramento Valley should look to Davis trials while those in the low desert should refer to the trials in the Imperial Valley and Blythe. The two locations in the San Joaquin Valley represent very different soil types. Growers should choose the location that is most similar to their conditions. When possible, it can be helpful to compare varieties over more than one location, provided the environmental conditions are not too different.

Pest and Disease Resistance Ratings. Over the years, breeders have incorporated resistance to many insects, diseases, and nematodes that impact alfalfa growth. The selection of the proper variety in many circumstances can help with the development of an integrated pest management program. After considering yield potential, growers should review the pest and disease resistance levels for the varieties they are considering. The best source of this information is the National Alfalfa and Forage Alliance (NAFA) publication, "Winter Survival, Fall Dormancy & Pest Resistance Ratings for Alfalfa Varieties." The 2013 edition is now available on-line (www.alfalfa.org). This publication lists all the commercial varieties available in the US with information on fall dormancy, winter survival, insect and disease resistance, other traits, and the company that markets the variety.

It is important to understand how pest/disease resistance works in alfalfa. Unlike corn or wheat, in which each plant of the same variety is nearly genetically identical to other plants of that variety, alfalfa cultivars are populations of genetically diverse plants. For example, with a corn variety that has resistance to rust, every plant in the variety will have the same resistance to the disease. With an alfalfa variety, only a percentage of the plants will be resistant to a specific pest or disease. This definition of resistance in alfalfa is quite unique and is summarized in Table 2.If a variety is described as being Highly Resistant to a pest or disease, it means the majority of the plants would be resistant but some proportion remains susceptible. In addition, the information in the pamphlet is provided by seed companies that develop and market the respective varieties. Tests, often conducted in greenhouses or laboratories with seedling plants, are not always

analogous to what happens in the real world out in a grower's field. In a commercial field, older or stressed plants, or intensity of the pest pressure, could result in more damage than one would expect from the resistance rating. Despite these limitations in testing protocols, genetic resistance is a valuable asset for managing pathogens, nematodes and insect pests. Especially with pathogens and nematodes, resistance is the primary method of minimizing their impact on the crop.

Table 2. Description of resistance classes in alfalfa.

Resistance Class	**Percent (%) Resistant Plants**
Susceptible (S)	0 - 5
Low Resistance (LR)	6 - 14
Moderate Resistance (MR)	15 - 30
Resistant (R)	31 - 50
High Resistance (HR)	>50

Depending on where alfalfa is grown, the recommended resistance levels for different diseases, insects, and nematodes vary. For example, Verticillium Wilt is not of concern in the low desert areas and therefore varieties planted in the Imperial Valley can be susceptible; however if planting in the high desert where Verticillium Wilt can be important, a Highly Resistant variety is recommended. The recommended resistance levels for alfalfa production areas in CA for several diseases, insects, and nematodes are listed in Table 3.It can sometimes be difficult to find a high yielding variety with all the suggested resistance levels. Knowing the local area or characteristics of the field can help a grower determine which ones are most important. For example, stem nematodes are rarely a problem south of Fresno County in the San Joaquin Valley unless sprinkler irrigation is used. Therefore, a grower in Kern County might choose a variety that yielded higher but had less resistance to stem nematode while a grower in San Joaquin County, knowing that stem nematode has been a problem in the past might not want to take the risk of a more susceptible variety even though it ranked higher in yield in the variety trial. Soil type might also influence how a grower would choose between two varieties which produced equally well in the variety trials. On a heavy soil with slow drainage, a high level of resistance to Phytophthora root rot would be more important than resistance to root knot nematodes which are more likely to be a problem in sandy soils.

Table 3. Suggested fall dormancy and disease and nematode resistance ratings for the different climatic zones in California.

Zone	**FD**	**BW**	**VW**	**FW**	**PRR**	**SAA**	**PA**	**BAA**	**SN**	**SRKN**	**NRKN**
Intermountain	3-5	R	R	HR	R	S	R	MR	HR	R	RR
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	H

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

Adapted from: Irrigated Alfalfa Management for Mediterranean and Desert Zones, UCANR Publication 3512

Quality. There are quality differences among varieties but they are rarely quantified in trials because laboratory analyses are costly and because quality is so closely related to maturity. In trials that include varieties with a range of dormancy ratings, it is visually obvious that varieties that are less dormant tend to start regrowing more rapidly than more dormant varieties. If all varieties are harvested the same number of days after the previous cutting, the more dormant, slower growing varieties tend to have higher quality (lower ADF and NDF values) – but also less yield. Therefore, at the same cutting schedule, more dormant varieties tend to be higher in quality but it is also true that these varieties tend to be lower in yield.

Additionally, "real world" management can overshadow small differences in quality among varieties. Cutting schedules can be designed to maximize quality during some cuttings and allow for longer intervals when quality is hard to achieve, for example in mid- summer (see "Adjusting Alfalfa Cutting Schedules for Economic Conditions," 33rd California Alfalfa and Forage Symposium). Raking and baling can impact leaf retention and influence the quality in the bale much more than varietal differences. Although variety choice (largely by choosing to grower more dormant varieties) can manipulate quality in alfalfa, management factors are much more important.

Stand Persistence. Stands persist longer in some parts of the state compared to other areas. In the Intermountain areas in the north, a 5-7 year stand life is the norm but in the southern San Joaquin Valley, most stands are usually kept for only 3 years. Stand persistence is primarily influenced by harvest traffic, irrigation practices, root diseases and nematodes. Variety tests, such as those conducted by UC, demonstrate which varieties still produce well at the end of the multiple-year trial. Review the trial summaries to see how the varieties were ranked each year. Some varieties start slow in the first year but rank near the top by the end of the trial. Others are fast starters but yields drop significantly relative to other varieties by the last year of the trial. A grower who plans to keep a stand longer than average would want to be sure to choose a variety that looks like it is still producing well in the last year of the trial.

Special Characteristics. If interested in multifoliolate or hybrid varieties, evaluate out how they perform in yield trials. If the trait adds value, the variety should rank with the higher yielding varieties or a quality benefit should be documented.

A new addition to the "Winter Survival, Fall Dormancy and Pest Resistance Ratings for Alfalfa" publication produced by NAFA is salt tolerance, either for germination purposes or for forage production, or both. These characteristics are relatively new and may not have been fully tested in replicated field trials. Salt tolerance is determined by controlled greenhouse tests. It is difficult to duplicate in trials all the salt conditions that may occur in fields. In salt-affected fields, it may be worth trying several of these varieties if they are available in the appropriate fall dormancy class for your area. It might be helpful to plant them in strips to compare to currently used cultivars to determine if the level of salt tolerance is beneficial under your specific conditions. There may be differences between salt tolerance during germination and salt tolerance of established plants: it is frequently recommended to use non-saline water for establishment with sprinklers before challenging the plants with more saline water.

Currently, the only commercially available biotech trait in alfalfa is tolerance to glyphosate with Roundup Ready varieties. As a whole these varieties yield as well as conventional varieties but there are high-yielding and low-yielding Roundup Ready varieties. The economics of choosing a RR alfalfa variety (they tend to be about $3.00 more per lb of seed) should be based on the economics of the weed control strategy, the cost/benefit of utilizing that strategy vs. conventional herbicides. If a grower wants to utilize the Roundup Ready technology for managing weeds, then use the same decision- making process in choosing the best RR variety as used for choosing a conventional variety.

Blends are not true varieties but a mixture of seed from different varieties. From year to year, even though the name of the blend may not change, the components or varieties that make up the blend can change. Blends are not included in UC trials because they may be different from one year to the next. A grower can buy a blend one year, be really happy with it, and then buy it again the next year only to have a very different experience. If a grower wants to purchase a blend, make sure that it's a certified blend, so that the source and mix of the seed is known.

Cost of Seed. The cost of seed should not be a factor in choosing which variety to plant. Seed cost is a relatively small percentage of establishment costs and, when compared to the production costs over the life of the stand, a very minor cost. In "Irrigated Alfalfa Management for Mediterranean and Desert Zones," seed cost was less than 14% of establishment costs and less than 3% of production costs for a 4-year stand. From another perspective, if the seed of a better variety costs $2 more per pound than a seed on "special," and the seeding rate is 25 lbs/acre, the yield increase of the better seed only has to be less than half a ton over the entire life of the stand to cover the increased cost of the seed if alfalfa is selling for $150/ton. If alfalfa is selling for a higher price, even less yield increase is necessary to pay for the increased seed cost. Performance is almost always more important economically than the seed cost.

Certified Seed. The only way to be sure that a bag of seed contains the desired variety, has a guaranteed germination percent, and is free of noxious weeds, such as dodder, is to buy certified seed. The cost of certified seed is justified using similar logic to the general argument in the paragraph above. Poor germination, introduction of problem weeds, or simply not planting the desired variety could be very costly to the grower in the long run.

DIY Variety Trials (On-Farm Strip Trials). In most cases, after reviewing yield trials, resistance levels, and other information, the list of possible varieties to plant will be whittled down to half a dozen or so that should do well. If planting more than one field, try more than one of the promising varieties. Large acreage growers may want to do some limited variety trials of their own (Do It Yourself – DIY). If so, plant more than one strip of each variety in a field, remember what varieties were planted where, and follow through with yield data and notes on growth, pest issues and quality. Use caution when comparing varieties planted in different fields because other management and environmental factors (i.e. planting date, soil type, fertility, irrigation, cutting schedule, etc.) can outweigh the effect of the genetics of the variety, and the grower can come to the wrong conclusion about variety performance. Replicated alternating strips of different varieties in the same field provide the most valid comparison of varieties.

CONCLUSIONS

The large number of varieties, the varied soils and climates within California, and the range of pest and disease problems make choosing which variety to plant a challenge. In addition, breeders have been successful in improving the yield potential and pest resistance of new varieties so it is important to review trials each year instead of relying on “tried and true” varieties. Results from University variety trials and information on pest resistance are resources that growers should use to choose varieties that will improve the economic returns from their alfalfa enterprises. Suggested steps in the variety selection decision process are listed in Table 4. Use variety trial information from the appropriate area to determine the highest yielding varieties. Select the dormancy that is best adapted to your area. Top yielding varieties in most trials often consist of a range of Fall Dormancy classes. If planting a variety with less fall dormancy than previous plantings, be sure to consider how to handle additional fall or winter growth. Growers can use their own experience and consult with UCCE Farm Advisors and Pest Control Advisors to determine which pests and diseases are most important in their local area. This information can be used to compare the resistance levels of the varieties under consideration. If there is information on stand persistence and quality then these variables can factor into the final decision.

Table 4.Steps for choosing an alfalfa variety for your field:

1. **Choose a high yielding variety**. Yield is generally the most important factor for economic returns. Yield performance of a variety integrates many components including fall dormancy, pest and disease resistance, and persistence. Refer to the UC Variety Test from the location most relevant to your production area. Rely on multi-year data and choose a group of the best varieties to consider.

2. **Choose appropriate Fall Dormancy class.** Often the leading varieties in the trial represent more than one Fall Dormancy class. Determine the Fall Dormancy level that best suits your location, severity of winter, harvest schedule and late fall/winter management options.

3. **Determine the pest and disease resistance characteristics** that are most important in your production area. Remember that genetic resistance is often the only mechanism available for managing some diseases and pests. Even if they are not a problem every year, resistant varieties may be the only way to minimize damage. A periodic pest can cause severe damage in individual years when it occurs but its potential impact may not be captured in standard yield data.

4. **Look for evidence of better persistence and forage quality**. Evidence of good persistence often can be deduced from performance during the later years of multi-year trials. Quality data is harder to find, in part because maturity differences confound quality differences in trials and management practices can mask genetic differences in the field.

5. **Biotech Traits.** At this time, the glyphosate-tolerant trait (roundup Ready) is available in nearly all dormancy classes. This shod be analyzed primarily as a weed control strategy, and the economics of this strategy and consumer acceptance of GMO traits should be considered. The same criteria (yield, Fall Dormancy, pest resistance, persistence) apply to RR varieties as to conventional varieties.

6. **Price.** Once you have selected several potential varieties based on the above considerations, only then consider price and service. Regardless of which variety selected, buy certified seed.

Adapted from "Considerations in Choosing an Alfalfa Variety," Poole, G. et al. In:33rd Alfalfa and Forage Symposium, 2010

Web Site Resources:

Searchable Index of Proceedings of previous Alfalfa Symposia, UC Alfalfa Workgroup: http://alfalfa.ucdavis.edu
Click on "Symposium" on the horizontal bar near the top of the page

California Alfalfa Variety Trial Results, UC Alfalfa Workgroup: www.alfalfa.ucdavis.edu
Click on "Variety Selection" in the horizontal bar near the top of the page

Winter Survival, Fall Dormancy & Pest Resistance Ratings for Alfalfa Varieties, National Alfalfa and Forage Alliance: www.alfalfa.org

Alfalfa Variety Trials – Other States

Idaho: www.extension.uidaho.edu/forage/varietytests/varietytest.htm

New Mexico: http://aces.nmsu.edu/pubs/variety_trials/

Oregon: http://Oregonstate.edu/dept/coarc/
Scroll to Alfalfa Hay and click on "More information about Alfalfa Hay"

Washington:www.wa-hay.org/publications

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