PRODUCING ALFALFA HAY ORGANICALLY

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ABSTRACT

The rise in the demand for organic feed makes alfalfa an attractive crop for some organic farmers where there can be about a 10% premium over conventionally grown alfalfa hay. This need for organic feed is primarily driven by the rise in demand for organic dairy products whereby cows producing organic milk must be fed organic feed. Other markets for organic alfalfa include organic beef and lamb production and racehorses. Growing alfalfa organically can be quite challenging as compared with conventionally produced alfalfa hay. First, organic alfalfa production involves growing, labeling, and marketing according to National Organic Program (NOP) standards as defined by the U. S. Department of Agriculture. Federal laws regulating organic products require producers to be certified organic through a USDA accredited certifier (public or private) and they must also register with the California Department of Food and Agriculture's Organic Program. Second, unless properly established and managed, there can be a reduction in yield and quality associated with increased weed and pest pressure and maintaining adequate soil fertility in organically managed fields. Fortunately, there are a number of pest and disease resistant varieties as well as organically approved tools available for use in alfalfa production. Since alfalfa is a legume, it requires no applied nitrogen just like conventionally grown alfalfa, but supplying the necessary phosphorus and potassium may be more costly. The purpose of this paper is to present information on how to produce alfalfa organically from the establishment to production phase.

INTRODUCTION

Organic alfalfa production involves growing, labeling, and marketing according to National Organic Program (NOP) standards as defined by the U. S. Department of Agriculture (USDA, 2005). These standards require that alfalfa be produced with approved inputs given in the national materials list with brand names listed by the Washington State Department of Agriculture (WSDA, 2005) or the Organic Materials Review Institute (OMRI, 2005). Farmers must also take precautions against pesticide drift and other sources of contaminants. In addition, hay handling equipment as well as storage areas must be designated organic or properly cleaned between conventional and organic use. Fields can qualify as organic by neglect, meaning they have had no prohibited substances applied for at least three years, or must be managed organically for at least three years prior to being certified as organic.

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Federal laws regulating organic products require producers to be certified organic through a USDA accredited certifier (public or private) and they must also register with the California Department of Food and Agriculture's Organic Program (COPA, 2003). This registration is handled through the County Agricultural Commissioner's Office throughout the state. The certification process requires that the producer develop a written organic farm plan that describes how the farm is to be managed in accordance with USDA-NOP rules and subsequent approval of the plan by the certifier. In addition, yearly updates to the farm plan are required as well as yearly on-site farm audits by certifiers to insure compliance with federal regulations.

Despite the extensive recordkeeping needed to produce alfalfa organically, the rise in the demand for organic feed makes alfalfa an attractive crop for some organic farmers where there can be about a 10% premium over conventionally grown alfalfa hay (Figures 1 and 2). This need for organic feed is primarily driven by the rise in demand for organic dairy products whereby cows producing organic milk must be fed organic feed. Other markets for organic alfalfa include organic beef and lamb production and racehorses.

Growing alfalfa organically can be quite challenging as compared with conventionally produced alfalfa hay. Unless properly established and managed, there can be a reduction in yield and quality associated with increased weed and pest pressure and maintaining adequate soil fertility. Fortunately, there are a number of pest and disease resistant varieties as well as organically approved tools available for use in alfalfa production. Since alfalfa is a legume, it requires no applied nitrogen just like conventionally grown alfalfa, but supplying the necessary phosphorus and potassium may be more costly. The purpose of this chapter is to present information on how to produce alfalfa organically from the establishment to production phase. When in doubt about any farming practice allowed for organic crop production, check with the USDA guidelines, California Department of Food and Agriculture's organic program, or your certifier.

LAND PREPARATION

The basic cultural requirements for alfalfa production are similar whether the crop is grown organically or conventionally. The ground should be worked in the fall, as soon as the previous crop is harvested, to prepare a seedbed. Fields should be disked and landplaned and borders pulled up for irrigation checks. Beds should be listed where drainage is necessary and better irrigation water distribution is desired (such as on clay soils). Extra care should be taken to ensure that fields are leveled and well drained to prevent standing water and subsequent stand loss and weed problems because a healthy alfalfa stand competes well against weeds, pests, and diseases.

FERTILITY MANAGEMENT

Seedling fields

Prior to planting alfalfa, it is important to assess the fertility needs of the crop. See Chapter 6 for a more complete discussion of assessing nutrient requirements of alfalfa. Also, the NOP regulations require the calculation of nutrient needs of the crop and how those needs will be met. The high costs of organic versus synthetic nutrients (4-6 times higher for phosphorus and 2-3 times higher for potassium) makes careful analysis imperative. Sample soils according to the

guidelines in Chapter 6 to determine crop needs. Incorporate the recommended amounts of phosphorus and potassium as manure or other organically approved fertilizers into the soil (Table 1). If the soil pH is below 6.3, apply an organically approved liming material or petition for use of the nearest source for economic considerations. For growers transitioning into organic alfalfa production that have soils that require large amounts of lime, phosphorus, and potassium, it may be more economical to build up the soil fertility by adding synthetic fertilizers and focus on weed and insect control prior to the 3-year transition period to organic production.

Compared to commercial fertilizers such as 0-46-0, 11-52-0, or 0-0-60, organic manure and compost fertilizers have relatively low concentrations of actual nutrients which can vary widely (usually 0.5-3% each of nitrogen, N, phosphorus, P_2O_5, and potassium, K_2O). In addition, most organically approved materials also have a wide range in moisture content (10-40% or more) so the quantity of nutrients applied must be adjusted based on the actual moisture content. For example, a ton of moist manure or compost may range from only 1400 lbs. of dry weight (30% moisture) up to as much as 1800 lbs. of dry weight (10% moisture). As a result, if the phosphorus content is 1% P_2O_5, then there would be 14 lbs P_2O_5 per ton in a 30% moisture material, whereas a 10% moisture manure or compost would contain 18 lbs P_2O_5 per ton. If the manure or compost analysis is reported as phosphorus (P) instead of (P_2O_5) concentration, then multiply P by 2.29 to get the P_2O_5 content. Since suppliers give only estimates of both the moisture content and nutrient content, take several samples of the manure or compost and have them analyzed for moisture and nutrient content to get a more accurate estimate of the nutrients purchased and applied.

Some organic fertilizers contribute substantial amounts of organic matter, which often leads to an increase in water infiltration into the soil. Organic fertilizers may also improve the physical structure of the soil, which allows more air exchange with plant roots. Where organic sources are used for fertilizers, bacterial and fungal activity usually increases in the soil, which helps make nutrients and water available to plants. Because of the slow release of nutrients such as nitrate-nitrogen from the organic sources, alfalfa is a desirable crop because the deep roots take up the nitrates prior to being leached to groundwater. Manure and manure-based composts generally have higher phosphorus and potassium content than green wastes and other composts. The use of dairy and other lagoon waters as well as associated lagoon sludge should be evaluated with the organic certifier as to whether they meet organically approved guidelines particularly with respect to antibiotics in the manures.

Established fields

In an established alfalfa field, plant tissue analyses are valuable tools to monitor the nutritional status of the plants to make decisions about fertilization needs. For information on how to take plant tissue samples and interpret the test results, see Chapter 6, "Fertilizing alfalfa for optimum production." Soil fertility and the plant nutrient status can be maintained most effectively with animal manures, compost, green waste, and other approved organic fertilizers like potassium sulfate, potassium magnesium sulfate and elemental sulfur. Refer to the discussion under "Fertility Management-Seedling Fields" for an evaluation of manures and composts. Rock phosphate, which can be used as both a liming material and a phosphorus source on acid soils (below pH 6.5), is quite expensive and usually not as cost effective. Rock phosphate is almost

completely ineffective on alkaline soils (pH greater than 7.0) because soil acidity must dissolve the material before the phosphorus becomes available for use by plants.

Fertilizer application timing may be more important with organic alfalfa production than with conventional production due to the effect that organic fertilizer sources have on promoting weed growth. As a result, some variation in timing of organic fertilizer sources may be necessary depending on predominate weed species and the best time to feed alfalfa versus favoring competing weeds. Timing the application of manure or compost after the first or second cutting would give alfalfa the competitive edge to take up fertilizer nutrients rather than feeding the weeds. Since many organic fertilizer sources contain nitrogen, applications during the winter months would be more likely to encourage late winter-spring weed growth prior to when the alfalfa starts growing. Making a second application during August or September when the alfalfa is also growing vigorously, would also serve to benefit alfalfa over weeds.

SEED SELECTION AND PLANTING

Variety selection is an important step when establishing alfalfa stands. Select the appropriate dormancy type and make sure that local pest and disease resistance needs in your area are considered. Resistant varieties tolerant to pests are not completely resistant so additional pest control measures may be needed in years of heavy pest pressure. Selecting a variety that has a more non-dormant characteristic with faster re-growth will also inhibit weed germination and establishment.

USDA standards require the use of organic seeds as the National Organic Program regulations prescribe that an organic availability search clause procedure be outlined and approved by the certifier before certification can be granted. This committed procedure must be followed unless approval has been granted to purchase non-organic seeds. Conventionally grown seeds may be used as long as they are not genetically modified and there is clear documentation of 'non-availability' of organic seed from several sources. Inoculate the seed with the appropriate organically approved nitrogen-fixing bacteria (Rhizobium species) if alfalfa has not been grown in the area for at least 10 years. Use certified seed, as it will be nearly weed free. In general, the best time to plant alfalfa is in the fall (September-October) to encourage vigorous stands that out compete weeds. Seeding rates should be slightly higher than normal, 25-30 lbs/acre, to help suppress weeds. Seeds should be drilled, or broadcast and incorporated with a ringroller.

INSECT PEST MANAGEMENT

Insects can be managed in organic alfalfa production using a variety of tools, including varietal resistance, cultural practices such as early harvest, conservation of natural enemies, and the use of approved organic production insecticides, Table 2 (check both lists, WSDA, 2005 and OMRI, 2005). While pesticides on the national organic list can be used the other methods of control must be implemented first and only after they do not control the problems, then with documentation can the materials from the national list be used. For a more detailed discussion of the biology of insects found in alfalfa, including treatment threshold levels, see Chapter 9 as well as the University of California Pest Management Guidelines for alfalfa (UC IPM, 2004).

Egyptian and alfalfa weevils. Weevils are primarily a first cutting pest and are considered to be the most serious alfalfa pest for organic growers because there are ordinarily no economically viable control options. Organic pesticides may not provide economic control, there are no resistant varieties, and natural enemies do not provide adequate control. Early cutting before weevils reach peak numbers may help control this pest, but yield and quality of the first cutting is impacted. In addition, larvae that survive the harvest process may concentrate under the windrow causing extensive damage to alfalfa re-growth and possible stand loss.

Flaming with propane in late winter just prior to when the alfalfa breaks dormancy can reduce weevil populations, by killing adults as well as eggs deposited in stems. The charred alfalfa stubble may also be a less attractive environment for adults returning to the alfalfa field to lay eggs. However, the level of control with propane depends on the weevil pressure and is not as effective as the use of conventional insecticides. In addition, flaming may not be economically feasible given the high costs of fuel.

Grazing with sheep during the winter for weed control has also been shown to decrease the number of alfalfa weevil and increase yields, by killing the eggs and larvae in the plants (Buntin & Bouton 1996, Natwick et al. 2004). For this option to be viable timing is critical. Grazing must occur when the weevil eggs are hatching (usually January or February, depending on the location of the field). The animals should be managed carefully to prevent overgrazing and stand loss, especially under wet conditions.

Overseeding alfalfa in the fall with grass or legume forages, which are not hosts for the alfalfa weevil, will increase spring yields and help compensate for losses caused by weevil damage to the alfalfa. However, this practice changes the forage quality and perhaps even the market and value of the alfalfa. Overseeding may also reduce the vigor of the alfalfa and cause stand loss so this practice should generally only be considered in the final years of production.

Aphids. Most recently released alfalfa varieties have resistance to the pea, blue, and spotted alfalfa aphid. Organic growers should choose varieties that have the highest level of resistance possible to help control these pests. Preserving and enhancing naturally occurring predators, such as ladybugs, lacewings, and parasitic wasps that feed on aphids, will also help manage aphids. This can be done by border or strip cutting to leave habitat and some prey for the beneficial insects so they stay in the field. There is also a naturally occurring fungus that helps control aphids during warm, wet periods (turning them pink); however, it is not commercially available. Early harvest as well as flaming will also help control aphids, but is not likely to be economically viable. The use of pyrethrum or azadirachtin will also control springtime aphids in alfalfa if outbreaks occur.

Caterpillars. The beet and western yellow striped armyworms as well as the alfalfa caterpillar are the most serious caterpillar pests of alfalfa with outbreaks usually occurring in July and August. To control these pests, fields can be cut early, before significant damage occurs to the alfalfa. Most larvae that survive the cutting process are killed by the hot dry conditions following harvest so will not damage alfalfa re-growth under the windrows. However, the larger larvae can migrate to surrounding crops so it may be advisable to plow a ditch between the alfalfa and the adjacent crop and fill it with water to keep them from moving beyond the field.

Preservation and enhancement of naturally occurring beneficial insects will also help provide biological control of caterpillar pests. This can be done through strip or border cutting to help retain the beneficial insects in the field. The alfalfa caterpillar and beet and western yellow striped armyworms are also susceptible to the microbial insecticides, *Bacillus thuringiensis* (Bt), but mostly in the small larval stages.

Minor pests. The potato leafhopper and cowpea aphid are occasional pests of alfalfa. The potato leafhopper tends to be a mid-summer pest, but cowpea aphid may be a problem any time during the growing season. Early harvesting before significant damage is observed is often the best option to control both pests. For the potato leafhopper the stubble height should be no more that 2-3 inches (5-8 cm) to destroy as many eggs as possible.

WEED MANAGEMENT

Strategies for managing weeds in seedling and established organic alfalfa without herbicides involve a combination of practices, including good seed bed preparation, grazing, harrowing, flaming with liquid propane, adjusting irrigation and cutting schedules, and overseeding with alternative forages (Table 3). For more detailed information on all weed control practices in alfalfa, see Chapter 8.

Seedling fields

Establishing vigorous alfalfa fields is critical for weed management throughout the life of the alfalfa stand because strong stands outcompete weeds. Prior to planting, prepare a good seedbed, preferably on well-drained soils, to ensure good seed germination and prevent plant dieback as a result of standing water. Planting alfalfa in rows on beds or on shallow corrugations is commonly practiced in areas where soils lack sufficient drainage, but some organic growers have found increased weed problems in furrows.

Planting should occur in the fall (September to October) when conditions favor stand establishment. Alfalfa fields planted during winter (December) will grow too slowly, allowing winter weeds to take over, whereas those planted late spring will likely be overrun by summer weeds. Fall plantings are especially important for fields infested with field bindweed, perennial grasses, or nutsedge, to ensure that the alfalfa becomes well established to help outcompete these perennials when they start growing in the spring. If possible, a non-dormant variety should be selected to ensure fast re-growth following harvests to further help with weed suppression. Prior to planting, fields should be pre-irrigated to germinate weeds followed by tillage.

Interplanting oats with the alfalfa during stand establishment can suppress weeds without the use of herbicides and reduce soil erosion (Canevari *et al.*, 2000). The oat seed should be planted first, followed by the alfalfa once the oats germinate. The first several cuttings will be a mixture of oats and alfalfa, which will affect the marketability of the hay (dairy versus other feed). However, losses in quality should be offset by higher yields, and by the third cutting there should only be alfalfa with no impact on the stand. Curing time for the first cutting is several days longer than for alfalfa alone.

If weeds become established in seedling stands, fields should be cut close to the ground in the

spring to help inhibit weed growth. This will allow the alfalfa to re-grow and compete more successfully against existing weeds. In the low desert, sheep grazing is sometimes used to remove winter annual weeds in new plantings (Bell *et al.*, 1996). Harvest management practices should be followed as outlined in Chapter 13 to prevent stand injury as a result of cutting or grazing too early or under wet conditions.

Established fields

Grazing or "sheeping off" during the winter can provide good weed control, but the animals must be managed carefully to prevent overgrazing and stand loss. Harrowing also provides some winter weed control, but may cause some stand loss from uprooting and injury of the alfalfa crowns. Flaming can provide some control of seedling weeds, including dodder, but given the high cost of fuel this practice is best suited for spot treatments of weed-infested areas.

Adjusting irrigation and cutting schedules can also inhibit weeds and enhance stand life. Irrigating alfalfa as close to harvest as possible will allow the alfalfa to re-grow more quickly after cutting and provide shade that will help protect plants from root rot and scald. Shading also helps the alfalfa compete against seedling weeds. Dry soil after harvest also minimizes weed seed germination when the canopy is open. A shorter cutting interval improves forage quality, but reduces alfalfa vigor and encourages weed growth. As a result, alfalfa stands should be properly managed to take into account the tradeoff between times of cutting, yield, forage quality, and stand life.

Overseeding alfalfa stands with annual or perennial grasses or legumes will also help suppress weeds, but is only recommended for weakened stands that are in their final years of production (Canevari *et al.* 2000). Typically overseeding occurs in the fall after harrowing alfalfa fields to prepare a seedbed and the forage is seeded directly into the stand. Yields are enhanced for spring cuttings, but the forage is mixed, affecting forage quality and markets.

DISEASE AND NEMATODE MANAGEMENT

There are a number of diseases and plant parasitic nematodes that infect alfalfa. However, since there are no fungicides or non-fumigant nematicides registered for use in alfalfa in California, management practices are similar for control of these pathogens in both organic and conventional alfalfa systems. This includes the use of resistant plant varieties and cultural practices, such as irrigation management, field sanitation, crop rotation, and weed control. More information on these practices can be found in Chapter 10 for diseases and Chapter 11 for nematodes.

VERTEBRATE PEST MANAGEMENT

Vertebrate pests such as pocket gophers, ground squirrels, voles (meadow mice), and rabbits can be significant pests of alfalfa (see Chapter 12 on Vertebrate Pest Control). Since there are no organically approved rodenticides available for rodent control in alfalfa, vertebrate pests are difficult to control organically.

If there were problems with rodents in previous crops, consider rotating with cereal crops as this

practice may reduce gopher activity. Prior to planting alfalfa, check the field and the surrounding landscape to determine possible sources of vertebrate pests. Remove unmanaged cover along fencerows, roadsides and ditch banks where rodents often hide and build up to prevent them from dispersing into new alfalfa fields. During ground preparation, deep tillage can be used to disrupt or destroy ground squirrel burrows prior to planting alfalfa. However, gophers can survive cultivation and deep tillage and should be controlled where activity is observed, prior to planting.

Flood irrigation, while not eliminating pocket gophers, can significantly decrease their numbers and may reduce the potential for large populations to rebuild. Reducing the amount of vegetative cover during the winter months by mowing and grazing will also aid in reducing voles. Propane devices that ignite injected gas, causing the burrows to explode provide minimal control of ground squirrels. Shooting, trapping, and the use of owl boxes and perches for raptors may improve the control of some rodents.

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Table 1. Status of organic soil amendments and fertilizing materials in California[1].

Material[2]	Status[3]	Moisture (%)	$CaCO_3$ Equiv. (%)	P_2O_5 (%)[4]	K_2O (%)[4]	S (%)[4]
Liming Materials						
Ash, Wood or Fly Ash—Plant and animal sources only. Fly ash is generally 30-50% organic matter. Ash from minerals, manure or prohibited materials (glue, plastics or synthetic substances) is prohibited. Manure ash is prohibited because burning manure is wasteful of organic matter and nutrients.	R	5-20	5-50	0.1-3.0	2.0-20	0.1-3.0
Limestone-mined, Calcium Carbonate	A[5]	5-10	50-90			
Dolomite-mined[6], Magnesium Carbonate	A[5]	5-10	50-95			
Sugarbeet lime	P					
Compost						
Compost—(plant and animal materials). Composted plant and animal materials produced through a process that: (i) establishes an initial C:N ratio of between 25:1 and 40:1 and (ii) maintains a temperature of between 131°F and 170°F for 3 days using an in-vessel or static aerated pile system; or (iii) maintains a temperature of between 131°F and 170°F for 15 days using a windrow composting system, during which period, the composting materials must be turned a minimum of five times. Acceptable feedstocks include, but are not limited to, animal manure, by-products of agricultural commodities processing, and source-separated yard debris or "clean green."	A	1-50		0.1-2.0	0.3-2.0	0.1-0.3
Compost Tea—extract from sewage sludge and prohibited synthetic nutrient sources	P					
Manure						
Manure—Composted (See Compost)	A	1-50		0.2-2.5	0.4-3.0	0.1-0.4
Manure— Raw animal (Also Manure Tea, Slurry, Lagoon Water) Human waste products and sewage sludge are prohibited. Uncomposted manure can contain high levels of plant and human pathogens, weed seeds, volatile and soluble nitrogen and pesticide residues.	R	1-80		0.5-3.0	0.5-3.0	0.1-0.4
Other Sources of Macro and Secondary Nutrients						
Rock phosphate must not be fortified or	A[4]			0.5-		

processed with synthetic chemicals. Cannot be used in California if it originates from Northwestern United States.				3/		
Potassium chloride (KCl) Muriate of potash—Only from mined sources. Shall be used in a manner that prevents excessive chloride in soils.	R				60	
Potassium sulfate—non-synthetic (synthetic or that produced by acidulation or chemical reaction is prohibited.)	A[4]				50-52	18
Sulfate of Potash Magnesia or Potassium magnesium sulfate (Langbeinite)	A[4]				22	18
Sulfur-Elemental—as plant or soil amendment.	R	5-10				95-99
Gypsum	A	5-10				14-17
Micronutrients—Synthetic						
Use restricted to cases where soil/plant nutrient deficiency is documented by soil or plant tissue testing: (i) soluble boron products, (ii) sulfates, carbonates, oxides or silicates of manganese or sodium molybdate. Ammonium molybdate is prohibited.	R					
Other Materials						
Sewage Sludge, Biosolids	P					

[1]In California, a fertilizer is defined as a material having at least 5% by weight singly or in combination of nitrogen (N), phosphorus (P_2O_5) and potassium (K_2O).

[2]USDA-NOP, 2003. Organic Materials Review Institute Generic Materials List, June 2004, and Soil Improvement Committee, 2003.

[3]Status designations: **Allowed (A)** include non-synthetic materials that are not specifically prohibited by NOP Rule Section 205.602 and synthetic materials that are specifically allowed by Section 205.601. **Restricted (R)** substances are allowed in organic production subject to NOP Rule use restrictions. **Prohibited (P)** substances in crop production are generally defined in NOP Rule Section 205.105.

[4]Concentration is given on a 100% dry matter basis.

[5]A mined substance of low solubility.

[6]Dolomite contains both calcium and magnesium carbonate and excessive buildup of magnesium may be undesirable particularly on high magnesium soils.

[7]Total phosphorus content may range from approximately 18-25% but citrate and water-soluble phosphorus are much lower. Rock phosphate is almost completely ineffective on alkaline soils (pH greater 7.0) because soil acidity must dissolve the material before the phosphorus becomes available to plants. Also, the heavy metal concentrations prohibit the use of rock phosphate originating from the Northwestern United States sources.

Table 2. Organically approved methods for control of major insect pests in alfalfa in California[1].

Pest	Status[2]	Comments[3]
Egyptian Alfalfa Weevil		
Early harvest	A	Yield may be impacted. Less useful under high weevil pressure as significant damage may occur by the time the field is harvested.
Grazing or "sheeping off"	A	For maximum effectiveness, grazing must be timed at egg hatch (look for first signs of larvae and plant damage). Animals must be managed carefully to prevent overgrazing and stand loss, especially under wet conditions.
Flaming with propane	A	Timing should occur at egg hatch. Degree of control depends on the severity of the weevil infestation and may not be economical.
Overseeding	A	Alters quality and possibly yield of harvested forage.
Pyrethrum insecticide	R	Non-synthetic (PyGanic®, but may not be as effective and economical as synthetic insecticides).
Armyworms and alfalfa caterpillars		
Early harvest	A	Yield and quality may be impacted
Microbial insecticides	R	Most effective on smaller instars (XenTari®, Agree®)
Conservation of natural enemies	A	Border or strip harvesting
Aphids		
Varietal resistance	A	See http://alfalfa.ucdavis.edu for alfalfa varieties.
Conservation of natural enemies	A	Border or strip harvesting
Early harvest	A	Yields may be impacted
Pyrethrum insecticide	R	Non-synthetic (PyGanic®, but may not be economical).
Azadirachtin (Neem) insecticide	R	Non-synthetic, (Agroneem®, Neemix 4.5®, Trilogy®)

[1]The need for and use of insecticides derived from natural sources should be explained in the organic system plan. The organic system plan must justify that the use of cultural practices, preventive, mechanical, and physical methods are insufficient before organically approved insecticides are allowed.

[2]Status designations: **Allowed (A)** include non-synthetic materials that are not specifically prohibited by NOP Rule Section 205.602 and synthetic materials that are specifically allowed by Section 205.601. **Restricted (R)** substances are allowed in organic production subject to NOP Rule use restrictions. **Prohibited (P)** substances in crop production are generally defined in NOP Rule Section 205.105.

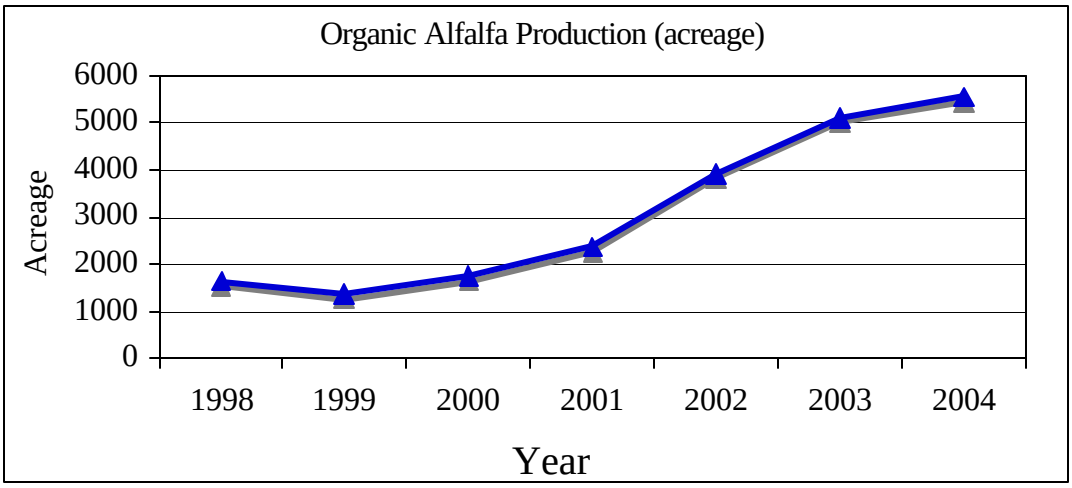
[3]Registered products available for use in organic alfalfa production in California, USDA-NOP, 2003, CDPR, 2005, Caldwell *et al.* 2005.

Table 3. Organically approved methods for weed control in alfalfa in California.

Stage of stand	Status[1]	Comments
Seedling fields		
Time of seeding	A	Seed early fall when summer weeds are not as competitive and before winter weeds germinate for optimum alfalfa vigor.
Early harvest	A	Yield, quality, and stand may be impacted, especially under high weed densities.
Grazing or "sheeping off"	A	Animals must be managed carefully to prevent soil compaction and stand loss, especially under wet conditions. Perennial and/or grass weeds less affected.
Interplanting oats with alfalfa	A	Generally lowers nutritional value of harvested forage.
Established fields		
Grazing or "sheeping off"	A	Animals must be managed carefully to prevent soil compaction and stand loss, especially under wet conditions.
Flaming with propane	A	Best used for spot treatment of weed-infested areas (such as dodder) due to the high fuel costs.
Adjust irrigation and cutting schedules	A	Most useful for management of summer weeds. Effectiveness depends on soil type and weed pressure.
Overseeding	A	Changes quality of harvested forage.
Tillage	A	Practice occurs when alfalfa is dormant. May injure alfalfa crowns leading to plant disease.

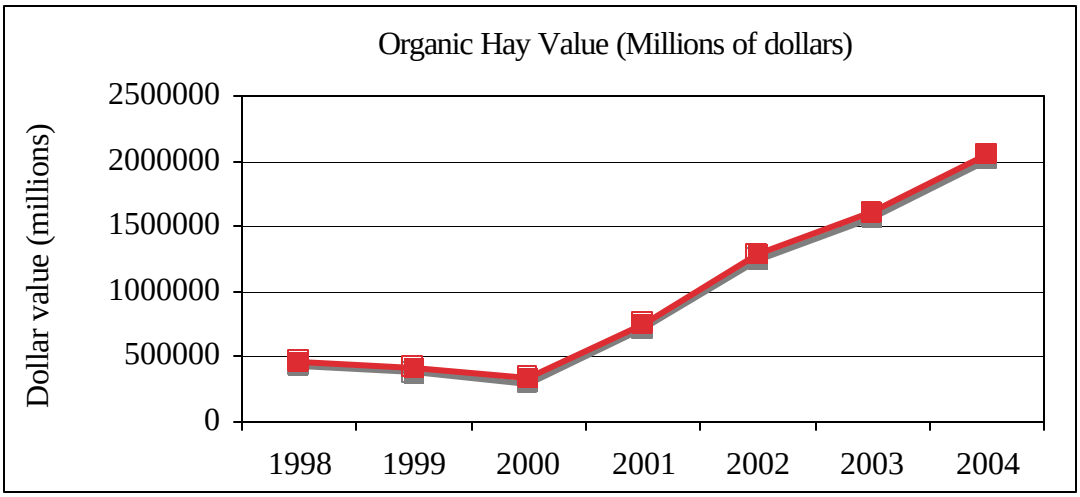
[1]Status designations: **Allowed (A)** include non-synthetic materials that are not specifically prohibited by NOP Rule Section 205.602 and synthetic materials that are specifically allowed by Section 205.601. **Restricted (R)** substances are allowed in organic production subject to NOP Rule use restrictions. **Prohibited (P)** substances in crop production are generally defined in NOP Rule Section 205.105.

Figure 1. Organic alfalfa production (acres) per year in California[1].



[1]CDFA 2005.

Figure 2. Value of organically produced hay in California (millions of dollars)[1].



[1]CDFA 2005.