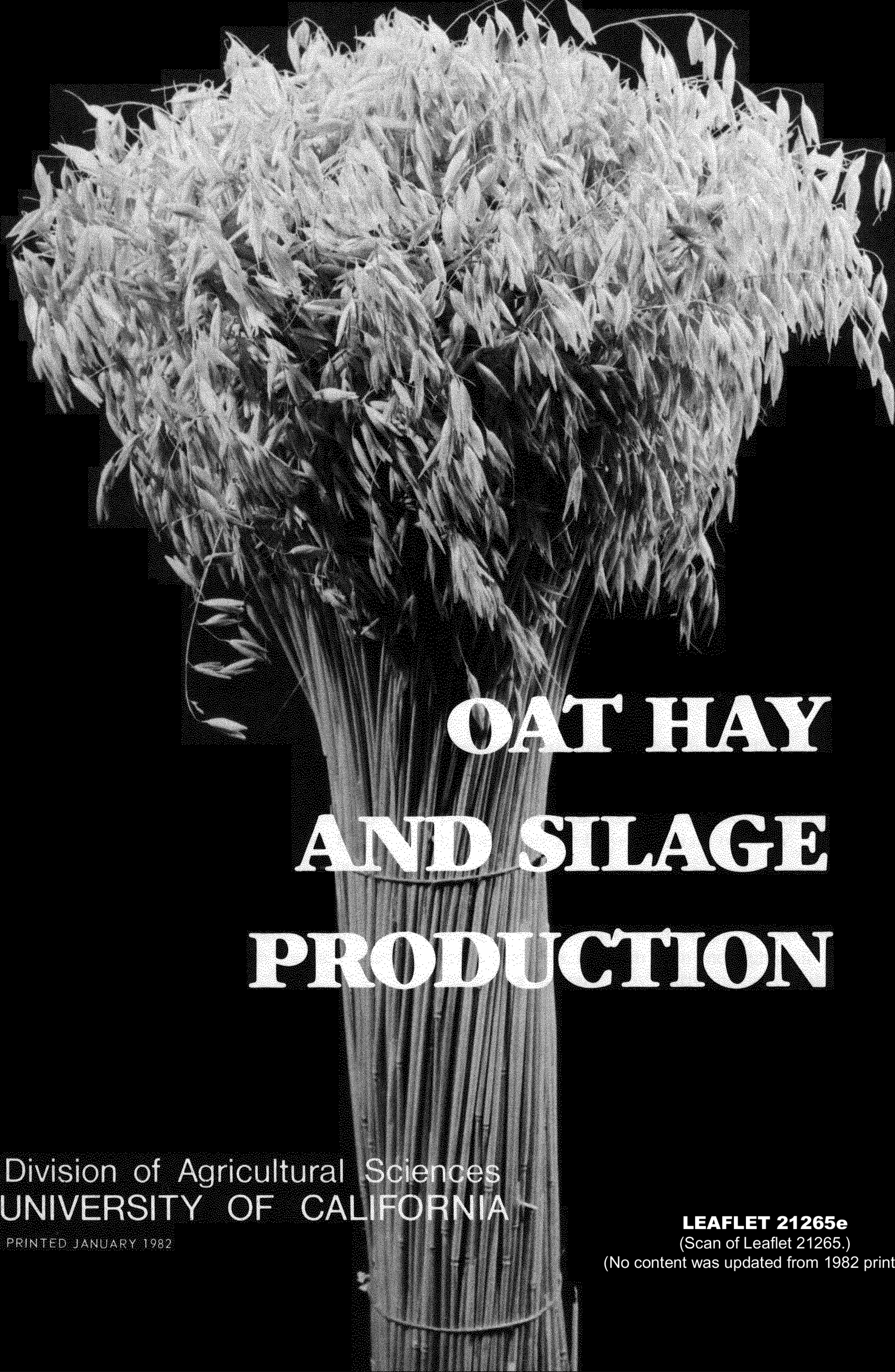


OAT HAY AND SILAGE PRODUCTION

Division of Agricultural Sciences
UNIVERSITY OF CALIFORNIA
PRINTED JANUARY 1982

LEAFLET 21265e
(Scan of Leaflet 21265.)
(No content was updated from 1982 printing.)

The authors are
Melvin R. George, agronomist, Cooperative Extension, UC Davis;
Thomas E. Kearney, farm advisor, and
Carl A. Schoner, Jr., county director, Cooperative Extension, Yolo County.

Formerly Circular 481

Oats are grown in almost every county in California to provide hay or silage for cattle, sheep and horses. The growing pleasure horse industry offers a ready market for high quality, pure oat hay, while dairies use oats alone for silage or in mixtures with other winter cereals. Oats are frequently grown with vetch or Austrian winter peas to increase the resulting forage's protein content. Winter forage or silage blends may include almost any combination of oats, barley, wheat, rye, triticale, ryegrass and vetch.

The exact amount of oat forage produced annually in California varies, but in 1978 and 1979 between 280,000 and 290,000 acres of grain hay produced 560,000 to 575,000 tons. In 1974, Sonoma, Stanislaus, Merced and San Luis Obispo counties were the leading producers of small grain hay, according to the Agricultural Census, In the same year 45,000 acres of grass silage and haylage produced 464,500 tons of green material. Leading counties in grass silage and haylage production were Stanislaus, Tulare, San Joaquin and Fresno; each has a large dairy industry.

Varieties

California oat varieties are classified as red oats because the husks vary from light to dark red. This is in contrast to white or yellow oats grown in humid areas of the United States. Red oat types evolved in the warmer, drier climate of the Mediterranean area and are more adaptable to the climatic conditions of California and the Southwest than are the white-yellow types.

California Red

History: A strain of Red Rustproof, once a dominant variety in the south central states. Numerous introductions, particularly of "Texas Red," were made. Not all present-day stocks are identical. The majority, however, can be traced to a mass purified stock first released as Foundation seed in 1937 by the University of California.

Description: Tall, fine stemmed, leafy, liberally pigmented with purple; late maturing, with a rather strong winter habit. Although moderately resistant to stem and crown rusts, California Red is the most susceptible, of any California oat variety, to barley yellow dwarf virus (BYDV).

Recommendation: Better suited for hay than for grain. Seed shatters if strong winds occur at maturity. Windrowing is suggested when harvesting for grain. It should never be sown in late winter because of the yellow dwarf virus hazard or where heat and drought are severe. California Red's fine stem and leafiness make it desirable for either dryland or irrigated hay.

Montezuma

History: Selected in 1965 from a group of 88 lines derived from oat Composite Cross II which involved crosses of cultivated oats with wild oats *(Avena fatua).* It was developed by C. A. Suneson, of USDA and U.C.

Description: Medium height, medium to fine stemmed, leafy, and earliest maturing of the California oat varieties. Susceptible to rusts when conditions are favorable for these diseases, Montezuma has been rated relatively tolerant of BYDV.

Recommendation: A dual purpose oat variety suited for both hay and grain. High grain yield and shatter resistance make it an especially desirable oat grain. Leafiness, medium stem and high grain yield make it a desirable hay. Early maturity makes it desirable for double cropping on irrigated lands. Montezuma is suitable for either dryland or irrigated hay and grain.

Sierra

History: Developed from a special cross of Kanota (*A. byzantina* L.) and a rust resistant wild selection of wild oats (*A. fatua* L.) by C. A. Suneson, USDA and U.C. It was released in 1962.

Description: Medium height, coarse stemmed, leafy with broad leaves and early maturing (a week later than Montezuma). Susceptible to rusts when conditions favor these diseases, Sierra has been rated relatively tolerant of BYDV.

Recommendation: A dual purpose oat variety, suited for both hay and grain. Its relatively high grain yield and shatter resistance make it an especially desirable oat grain. Leafiness and high grain yield make it a desirable hay, although some hay buyers may object to its relatively coarse stem. Sierra is suitable for either dryland or irrigated hay and grain.

Curt

History: Derived from crosses involving Victoria-Richland, Red Rustproof, Palestine and Kanota. Developed by C. A. Suneson at U.C. Davis, it was certified by the California Crop Improvement Association in 1958.

Description: A short, fine stemmed, leafy oat. Early maturing, similar to Montezuma, it is rated relatively tolerant to BYDV and is susceptible to rusts when conditions favor these diseases.

Recommendation: A dual purpose oat variety suited for both hay and grain. Curt has shatter resistance with grain yields slightly less than Montezuma and Sierra. Its fine stem, leafiness and moderately high grain yield make it a desirable hay, although yields have been somewhat less than Montezuma, Sierra and California Red. Curt is suitable for either dryland or irrigated hay and grain. Curt's early maturity makes it a desirable oat for double cropping on irrigated lands.

Kanota

History: A selected strain of Fulghum released by the Kansas Agricultural Experiment Station. Certified seed of Kanota was released in 1928 in California where it soon became a leading variety.

Description: Tall, medium stemmed, sparsely leafed. Seeds tend to shatter. Relatively early heading, being three to four days later than Montezuma, Kanota is as tolerant of BYDV as any variety grown in California.

Recommendation: Better suited for hay than for grain. Seed shatters if strong winds occur at maturity. Windrowing is suggested when harvesting for grain. Kanota's maturity range and relatively stiff straw base make it very satisfactory for sowing with vetch. Its hay yields have been similar to those of Montezuma, and it is suitable for either dryland or irrigated hay.

Cayuse

History: A spring oat with light yellow grain from the 1952 cross of the varieties Craig and Alamo made by N. F. Jensen, Cornell University.

Description: A tall, moderately late maturing oat when grown in California. Panicles are open and spreading and the straw is strong and resistant to lodging. Resistant to helminthisporium blight, it is also highly resistant to New York smut races and is tolerant to rust in California. Its yellow dwarf tolerance is expressed mainly as its yielding ability in spite of moderate discoloration after severe attack by viriliferous aphids. A weakness is the relatively low weight of its seed. The grain averages about 35 pounds per bushel.

Recommendation: Best suited for irrigated hay. It is not usually recommended as a dryland variety in the Sacramento Valley because of its late maturity. With adequate moisture and high fertility, Cayuse is a high yielding hay or silage oat. Growers may wish to consider harvesting it in the flower stage (shortly after heading) to increase protein and green color, decrease plant height and increase stem pliability. This variety has been the highest yielding oat in forage trials at U.C. Davis. When cut at the flower stage, it yields more total tonnage than most varieties harvested in soft dough.

Swan

History: Released by the Western Australia Department of Agriculture in 1967; a sister line to the variety Irwin. It was bred from a cross of the varieties Kent and Ballidu.

Description: Tall, medium diameter stem, leafy, early in maturity (a week later than Montezuma). Swan is moderately susceptible to rust when conditions favor these disease organisms; it has been rated relatively tolerant to BYDV Grain yields have been slightly less than Montezuma and Sierra in southern California tests. The lightly awned grain has excellent bushel weights.

Recommendation: A dual purpose oat variety suited for both hay and grain. Swan has produced high hay yields, irrigated and dryland. It is leafy, medium stemmed and demonstrates greater resistance to lodging than other varieties tested. This new variety was released in 1981 by the Department of Agronomy and Range Science at U.C. Davis. Swan is a good choice for planting with vetch because of its maturity range and resistance to lodging.

Coker 227

History: Developed and patented by Coker Pedigreed Seed Company in South Carolina. It can only be sold as Certified seed.

Description: Medium in height, medium stemmed, leafy. It matures 10 days later than Montezuma. Coker 227 tolerates rust and is very tolerant of BYDV.

Recommendation: On the basis of two years testing in Yolo County appears to be equal to Montezuma in hay yielding ability, equal to Montezuma in tolerance to BYDV and more tolerant of rust diseases than Montezuma. When harvested at the soft dough stage, Coker 227 will be a week to 10 days later than Montezuma but earlier than California Red.

Hay Quality

Although the direct relationship to hay quality is not known, fine stems and leafiness are often considered quality factors in oat hay. California Red has fineness of stem and leafiness superior to Curt, Montezuma, Swan, Cayuse and Sierra. Curt is next to California Red oats in fineness of stem and is only slightly less leafy. Montezuma oat stems are slightly larger in diameter and the variety appears slightly less leafy. Swan and Cayuse stems are somewhat coarser than Montezuma, but they are equally l e e . Sierra stems can be very coarse when grown in high yielding environments, but Sierra has many large, broad leaves. All six varieties are palatable to livestock when cut at the proper stage of maturity.

Tables 1 and 2 present hay yields for several oat varieties used in California. Irrigated trials were conducted at U.C. Davis and dryland trials were conducted in western Yolo County. Table 3 compares six oat hay varieties grown for hay in the Sacramento Valley.

TABLE 1. Hay Yield of Seven Oat Varieties, Irrigated Land Trials, UC Davis. Yield in Tons Dry Matter Per Acre.

	Harvest Year							Average	
Variety	**1970**	**1975**	**1976**	**1977**	**1979**	**1980**	**1981**	**Tons**	**%Montezuma**
Cayuse	–	9.17	7.88	7.39	8.70	9.44	5.62	8.03	125
Cayuse (flower stage)	–	–	–	–	7.33	8.31	–	7.82	131
Swan	–	8.28	7.55	6.34	7.79	7.60	6.30	7.31	114
Sierra	8.61	7.51	7.26	7.47	6.92	7.22	9.24	7.75	119
California Red	6.87	7.59	–	6.38	5.81	6.60	4.84	6.35	99
Kanota	–	6.68	7.10	6.45	–	–	–	6.74	107
Montezuma	7.03	6.26	7.01	5.71	5.45	6.52	7.44	6.49	100
Curt	5.14	5.66	–	–	5.56	6.22	7.39	5.99	92

TABLE 2. Hay Yield of Nine Oat Varieties, Dryland Trials, Yolo County, Yield in Tons Dry Matter Per Acre.

	Harvest Year													Average	
Variety	1965	1966	1967	1968	1969	1970	1972	1974	1975	1977	1978	1980	1981	Tons	%CalifRed
Cayuse	—	—	—	—	—	—	—	1.77	5.08	1.72	4.09	5.00	6.64	4.05	114
Swan	—	—	—	—	—	—	3.15	1.81	4.75	1.58	4.21	3.84	5.54	3.55	101
Avon	—	—	—	—	—	—	—	—	—	—	—	4.24	—	4.24	103
California Red	4.75	2.24	4.58	4.29	3.91	2.58	3.30	.99	4.81	1.63	3.63	4.12	6.06	3.61	100
Montezuma	—	—	—	4.14	3.06	1.63	3.41	1.82	5.18	1.76	3.51	3.63	4.78	3.29	93
Sierra	4.15	1.72	3.36	3.82	3.16	2.04	3.08	1.59	4.68	1.82	3.99	—	—	3.04	91
Coker 227	—	—	—	—	—	—	—	—	—	—	—	3.69	4.75	4.22	83
Curt	3.72	2.09	3.57	3.69	2.92	1.53	3.37	1.43	4.84	—	3.51	—	—	3.07	87
Kanota	4.02	1.74	3.68	—	3.90	—	—	—	—	1.61	—	—	—	2.99	87

TABLE 3. A Comparison of Six Oat Varieties Grown for Hay in the Sacramento Valley.

	Height (Inches)						Disease Resistance				Grain Production	
Variety	Dryland	Irrigated	Stem Diameter	Leafiness	Leaf Width	Lodging	Yellow Dwarf	Rust	Maturity Relative to Montezuma[1]	Average Harvest Date[2]	Yield	Shatter
California Red	24-57	56-62	F	VLF	N	S	VS	T	+ 13 days	Late May	L	S
Montezuma	23-50	52-55	F to M	LF	M	T	T	S	0	Early to mid-May	H	S
Sierra	23-50	56-62	C	LF	B	T	MT	S	+ 6 days	Early to mid-May	H	R
Curt	21-48	43-48	F	VLF	N	S	MT	S	+ 2 days	Early to mid-May	H	R
Kanota	24-50	57-60	F to M	LF	M	S	VT	S	+ 4 days	Early to mid-May	L	S
Cayuse	29-52	58-69	M to C	VLF	B	T	MT	T	+ 20 days	Early June	M to H	R
Swan	20-53	57-62	M	LF	M	VT	T	MS	+ 6 days	Early to mid-May	M to H	MR

[1]Number of days later than Montezuma when all harvested at soft dough stage of maturity.

[2]Average harvest period for soft dough stage hay in the Sacramento Valley.

B = broad; C = coarse; F = fine; H = high; L = low; LF = leafy; M = medium; N = narrow; R = resistant; S = susceptible; T = tolerant; MR = moderately resistant; MS = moderately susceptible; MT = moderately tolerant; VLF = very leafy; VS = very susceptible; VT = very tolerant.

Cultural Practices

In California most oat hay is grown dryland. Dryfarmed oat hay can be grown annually (in high rainfall areas) or under a summer fallow system (every other year) where annual rainfall is less than 14 inches. Yields of dryfarmed oat hay vary widely from year to year depending on amount and distribution of rainfall (Table 3). Oats will produce substantially greater hay yields with irrigation on highly fertile soils than when dryfarmed on marginal soils.

In intensively farmed areas oats for hay can be a good choice as the first crop in a double cropping system because of the earliness of harvest. The oat hay crop can be removed three weeks to a month before barley or wheat are ready for grain harvest. In addition, the hay crop leaves a minimum of residue after harvest.

Oats are a good rotation crop in dryland barley and wheat growing areas because they are not susceptible to the same root and foliar diseases that affect other cereals. A hay crop can reduce weeds that often plague barley and wheat because the forage is cut at an immature stage and weeds do not have the opportunity to produce seeds. This is especially true, if oats are harvested for hay in the flower stage.

Seedbed Preparation

Summer fallow method. Seedbed preparation with summer fallowing consists of spring plowing or chiselling, followed by disking and harrowing. Plowing starts after volunteer cereals and weeds have made some growth but before weeds have made seed and while there is ample soil moisture for easy tilling. Summer fallowing allows seedbed preparation well before the normal fall planting period. This permits fall planting before significant rainfall has occurred. Summer fallowing is highly desired under dry farm conditions because it permits timely planting, reduces weed problems, stores moisture and increases soil fertility, thus reducing fertilizer cost. The main disadvantage is that only one crop is obtained every two years.

Annual dryland cropping. Seedbed preparation begins with disking or chiselling dry soil in early summer. However, it is usually necessary to wait until after fall rains to prepare a satisfactory seedbed; then, seedbed preparation is completed with shallow chiselling or disking and harrowing. Disadvantages of annual cropping are: increased tillage and fertilizer costs, increased risk of crop failure due to inadequate moisture and buildup of weeds and crop diseases due to more frequent cropping.

Irrigated cropping. In irrigated areas seedbed preparation depends on the amount of crop residue present and soil compaction. It may be necessary to plow or chisel to bury previous crop residue and alleviate soil compaction. Plowing or chiselling is followed by disking and harrowing for final seedbed preparation. At times floating or finish leveling may facilitate irrigation. Following summer crops that leave little residue, a seedbed can often be prepared by disking several times and harrowing.

Planting Date

The growth cycle of oats, a winter annual, should correspond to the rainy season. With dry farming early fall plantings allow oats to benefit from natural rainfall and cool temperature, particularly in dryland areas with shallow soils. Early planting is less inipportant on deep soils with adequate moisture storage or on land that can be irrigated. Late planted oats may complete their growth cycle so rapidly that the plants do not have time to obtain optimum size for maximum production. A general statement is: The earlier oats are planted, the greater height they will attain. November is the month recommended for planting in the Sacramento Valley however, planting dates range from October through January.

Planting Rates

Oats contain from 11,700 to 15,400 seeds per pound, depending on the variety and bushel weight. (See Table 4.) Recommended seeding rates range from 70 to 100 pounds per acre. Drilling is preferred over broadcast plantings because it savesseed. ensures better germination and produces more uniform stands. Planting depth is not as critical for oats as it is with barley and wheat because oat seedlings can emerge from greater soil depths. Recommended planting depth ranges from 1/2 inch to 2 inches.

If vetch is planted with oats, 60 to 75 pounds of oats should be seeded with enough vetch to total 100 pounds of seed per acre. Vetch production success fluctuates, depending on climatic conditions; therefore, enough oats should be planted to give a hay crop even if the vetch fails to establish or be productive.

Oats may also be interseeded into sparse alfalfa stands to increase hay production of the first cutting in the last year of the stand. An early maturing oat variety seeded at 60 lb/A is recommended for this purpose. Traditionally the seed is broadcast after springtooth harrowing the alfalfa stand. The seed is covered by light harrowing. The number of trips over the field can be reduced if the seed is drilled with one of the grassland drills or interseeders introduced to California by various seed companies and agricultural equipment companies.

TABLE 4. Seed Weights for Seven Oat Varieties Commonly Grown in California.

Variety	Seeds per lb
Curt	11,705
Montezuma	11,859
California Red	13,244
Swan	10,611
Cayuse	15,376
Kanota	14,871
Sierra	11,311

Fertilization

Nitrogen. The fertilizer element most needed by oats in California. Suggested application rates are as follows:

- Annual dryland cropping: 30 to 80 pounds of nitrogen per acre.
- Summer fallow dryland: 20 to 60 pounds of nitrogen.
- Irrigated area: 20 to 80 pounds of nitrogen.

Up to 25 pounds of nitrogen can be drilled with oat seed at planting. The balance of nitrogen fertilizer should be soil incorporated before planting. If plants develop deficiency symptoms early in spring, additional nitrogen can be applied as topdressing.

Phosphorus. The second most important fertilizer element for oat production. Most phosphorus deficiencies occur on upland and terrace soils. These soils occur on the edges of valleys and are usually farmed without irrigation; most are shallow with claypan or hardpan development. The sodium bicarbonate soil test is reliable for determining phosphorus requirements. A soil with a reading of less than 6 ppm is highly responsive (deficient); 6 to 12 ppm is probably responsive (probably deficient); and above 12 ppm is usually not responsive (not deficient). Deep alluvial soils which occupy most of the irrigated areas are adequate in phosphorus.

When phosphorus is needed, it should be drilled with the seed at planting. Broadcast phosphorus is less efficient. Where phosphorus cannot be drilled, it should be disked or harrowed into the soil at the time the seed is covered. The recommended rate for phosphorus is 20 to 40 pounds of P_2O_5 per acre. When drilling nitrogen-phosphorus fertilizer with the seed at planting, it is considered hazardous to use more than 150 pounds of total material per acre. High rates of fertilizer placed directly with the seed can burn seed. Phosphorus is relatively safe, whereas nitrogen and potassium are hazardous to seeds.

Sulfur. May be deficient in some areas. Most dry nitrogen-phosphorus fertilizers contain sulfur. Sulfur needs can best be met by using a sulfur-bearing fertilizer such as ammonium sulfate or ammonium phosphate sulfate.

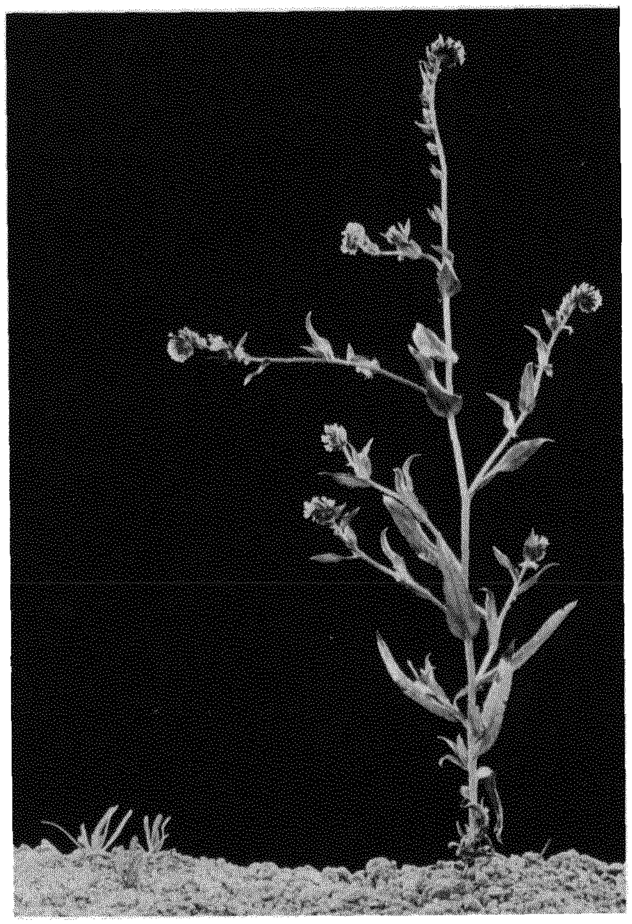
Irrigation

The moisture required to produce a crop of oat hay ranges from 10 to 19 inches, depending upon planting date and maturity range of the variety. Normally, one flood irrigation in the late boot stage of growth should carry the crop to harvest. Oats for hay should not be irrigated after heading because late irrigations frequently cause lodging.

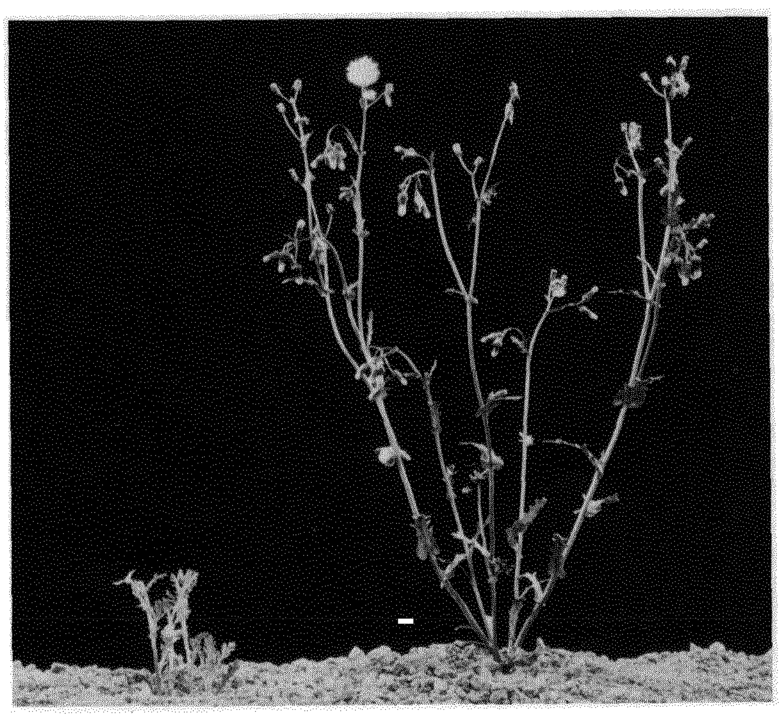
Lodging. Lodging of oats reduces hay yields and hay quality and increases difficulty of harvest. It does not usually occur with dryfarmed oats because the oats are shorter in stature and lower yielding than oats grown on fertile, irrigated soils. However, susceptible varieties will lodge if high winds occur near harvest time. Lodging is a serious consideration when oats are grown with irrigation on highly fertile soils. Oat varieties differ in resistance to lodging, with Swan being the most tolerant variety (Table 3). In areas where lodging is a problem it can be minimized by: (1) Selecting a tolerant oat variety, (2) irrigating *before heading,* and (3) cutting at flower stage to minimize exposure to high winds near harvest.

Weed Control

Two weeds are particularly detrimental, groundsel *(Senecio vulgaris)* and fiddleneck *(Amsinkia intermedia).* They frequently infest oat stands and contain alkaloids that are poisonous to livestock. Herbicide recommendations for these and other weeds are discussed in Leaflet 21254, *Weed Control in Oats.*



Fiddleneck: Seedlings are left, mature plant is right.



Groundsel: Seedling is to the left, mature plant to the right.

Harvesting

Oats are customarily harvested for hay when grain kernels are in the soft dough stage of maturity. At this stage, heads are filled with nearly mature grain and yield in tons per acre is at a maximum. Hay cut at the soft dough stage of maturity is preferred by most oat hay buyers, especially for the horse trade.

Oat feeding tests conducted with Kanota oats indicated that early flower stage hay may produce the highest nutrient yield per acre. Iambs fed 18 percent flower stage hay produced more gain per acre than lambs fed milk stage or dough stage hay. When oats are cut at early flower (just after heading), the percent protein and percent total digestible nutrients (TDN) are higher than in oats harvested at the milk or soft dough stage of maturity. Oats cut for hay at the milk stage produced the lowest daily lamb gains and less lamb gain per acre than hay cut at either early flower or the soft dough stages of maturity.

Results of these studies indicate two critical times for harvest, early flower and soft dough. Apparently the total nutrients realized from oats are greatest at about 18 to 20 percent flowering. If situations prevent harvesting oat forage at early flower, the forage should be allowed to mature to the soft dough stage rather than being harvested at an in-between milk stage.

Livestockmen raising oats for their own animals should consider cutting at early flower (just after heading). At this stage the percent protein and percent TDN are higher than at later stages of maturity. In addition, oats harvested at the flower stage will have more green leaves, and stems will be more pliable than when cut at later maturity.

Early harvest can be important with both dryland and irrigated oat hay plantings for reasons other than feeding value. Late-maturing oats grown dryland may fail to produce grain in exceptionally dry springs and early harvest may be of benefit when double cropping is planned on irrigated lands.

When early harvest is desirable, 14 to 21 days can be gained by cutting at the early flower stage. However, tonnage yields will be decreased as compared with dough stage hay (Table 5). Yield comparisons of flower and dough stage hays show that these oat varieties yield an average of 16 percent more dry matter when cut at the dough stage.

Silage Production

Hay crop silage is made by fermenting any moist hay or pasture crop. Making a hay crop into silage has the following advantages: (1) High quality forage that might otherwise be harvested as hay of inferior quality or lost because of inclement weather can be preserved. (2) The protein in home grown forages can be preserved, thus reducing requirements for purchased high protein supplements. (3) A high proportion of carotene is preserved, thus insuring against Vitamin A deficiency. (4) Little additional equipment expense is required for farms already producing corn silage. On these farms, silos can be used two or three months when they would otherwise be idle. (5)Hay crop silage is adapted to

TABLE 5. Hay Yield of Four Oat Varieties When Cut at Flower and Dough Stages of Maturity, Irrigated Areas.

	Cayuse		Swan		Sierra		Montezuma	
	Flower	Soft Dough	Flower	Soft Dough	Flower	Soft Dough	Flower	Soft Dough
1979 harvest dates	**5/23**	**6/9**	**5/4**	**5/27**	**5/7**	**5/29**	**5/1**	**5/24**
Dry matter (tons/A)	7.33[1]	8.70	5.80	7.79	5.01	6.92	4.98	5.45
Crude protein (%)	9.8	6.0	10.7	8.7	12.5	10.1	11.0	9.6
Moisture (%)	74	56	80	62	81	58	80	66
1980 harvest dates	**5/21**	**6/8**	**4/28**	**5/21**	**4/28**	**5/19**	**4/22**	**5/15**
Dry matter (tons/A)	8.31	9.44	6.07	7.60	5.93	7.22	4.83	6.52

1. Yield differences between cutting stages are highly significant.

fully mechanized storing and feeding. (6) More dry matter is conserved by ensiling than by field curing the same crop. (7) Crops can be harvested earlier, at their most nutritious stage. Ensiling will not improve the harvested forage's quality.

Disadvantages of hay crop silage include: (1) Storing a ton of crop as silage requires the handling of two to four times more weight than storing it as hay. (2) Additional equipment is needed if corn silage is not already being produced. (3) Silages made from high moisture crops that have received no wilting or preservatives often have an offensive odor. (4) Animals' dry matter consumption of these silages, especially those direct cut crops, is less than that of good hay. Therefore, silage is not as satisfactory as hay when it is the only forage in the ration.

Sealing Silos

In tower silos distributing and packing are by hand or with a mechanical rotary distributor at the top of the silo or, sometimes, dispensed with. In bunker or trench silos distributing and packing are usually done with a tractor equipped with a blade or scoop. A wheel-type tractor does a more solid packing job, but a crawler-type tractor is sometimes used because it is faster and more convenient.

Well packed silage will not be damaged as much by small air leaks in silo walls or the top seal as will loosely packed. An improperly sealed silo can waste the labor and expense of getting the crop into it. The top layer of silage should be sealed with a weighted plastic sheet as soon as possible after filling is completed. Soil, old tires, wet sawdust, limestone or waste forage is also good weighting material.

Silage Formation

Silage is formed by bacterial activity and other chemical changes in green forage stored in the absence of air. If air is not excluded from a moist stored forage crop, it will mold, rot and become useless. Sealing the crop from the air prevents this damage.

Bacteria that grow in the absence of oxygen produce organic acids by fermenting the crop's sugars and other carbohydrates. The organic acids formed stop further bacterial action and preserve the silage. Silages sealed against oxygen differ in quality, depending on the amount and type of acids formed by the fermentation and the amount of protein breakdown. Chemical composition of the plant, tightness of the air seal, type of chopping and speed of filling affect fermentation.

Wilted Silage

When wilting crops for silage, reduce the moisture content to about 70 percent by partial field drying. On a bright, hot day mown forage may wilt properly in two to three hours; during cool, cloudy periods wilting may require two or three days. Ensiling wilted crops results in little or no seepage loss.

The reduced weight of wilted silage makes it easier to handle than high moisture silage. However, making wilted silage by partial field curing is affected more by weather conditions than is the direct cut method.

Direct Cut Silage

Oats cut at the soft dough stage are usually close to the 60 to 70 percent moisture content desired for good silage.

High moisture silage has two basic disadvantages: (1) The extra water increases the problems of handling, seepage and silo pressures. Extra reinforcement should be added to silos when storing high moisture silage. (2) Fermentation of wet silage produces too much of the weak acids, such as butyric acid. Weak acid, high ammonia fermentations result in foul smelling, unpalatable silage.

This tendency towards poor fermentation is not consistent. Excellent fermentation sometimes occurs in high moisture silage; the reason for this is not clear. Because the fermentation of untreated high moisture forage is unpredictable, many growers add preservatives, although these often are not needed. Additives should do at least one of the following to be helpful: (1) Provide fermentable carbohydrates; (2) furnish additional acid to increase acid conditions; (3) specifically inhibit the undesirable types of bacteria; (4) directly or indirectly reduce the amount of oxygen present; (5) reduce the average moisture content of the silage and/or *(6)* absorb some seepage that might otherwise be lost.

Adding 60 to 100 pounds of molasses per ton of fresh forage will increase the percent of fermentable carbohydrates. This generally produces a silage that is sufficiently acid and of good quality. Because molasses must be diluted with water to obtain the proper rate of flow at the blower, water is added to an already high moisture silage. This increases seepage losses.

Adding 100 to 300 pounds of dry, ground grains or dry pulp products to direct cut forage on the load or at the blower will absorb much of the excess moisture and provide a source of carbohydrates. Although these feeds increase the feeding value of the silage, 15 to 20 percent of the feeding value of the added grain may be lost during the fermentation process.

Feedstuffs are not usually added at rates higher than 200 pounds per ton of forage. Reasons are initial expense, storage losses of the added feed and difficulty in efficiently using a silage that contains more than 30 percent of grain or pulp products.

Chemical preservatives thoroughly mixed with the chopped forage generally produce desirable fermentation and good silage, but they add nothing directly to the feeding value of the silage.

A chemical may be added to decrease the growth of bacteria that produce undesirable changes. This encourages development of desirable organisms and produces a good smelling, palatable silage. Sodium-metabisulfiteand certain commercial preparations containing organic acids, antioxidants and flavors are typical of this type of chemical preservative. They are most conveniently added at the blower during storage.

Direct cut forage should be chopped to a ½ inch cut and should be leveled and tramped especially well at the edges for at least the top one-third of the silo.

Treatment of silage with ammonia or sodium hydroxide has been shown to improve the digestibility of roughages and increase the TDN in the silage. This treatment is more useful with straws and other crop residues than with good quality oat forage.

Feeding Value

The feeding value of any forage depends on its digestible nutrient content and on the maximum amount that an animal will consume (acceptability). Fortunately, forages high in nutrient content tend to be highly acceptable, but both factors need to be considered in determining feeding value.

The content of digestible nutrients in silage depends to a great extent on the content in the original crop. No ensiling method improves forage, but some methods are more desirable than others because they allow less change in composition.

Silage contains, on a percent composition basis, slightly less crude protein than the original forage and less nitrogen-free extract; it contains more crude fiber and crude fat. Extensive leaching or poor air exclusion intensifies these differences.

Hay Crop Silage and Corn Silage

The nutrient content of hay crop plants is basically different from that of corn plants, but one type of silage may replace the other on a dry matter basis if the grain ration is adjusted to meet nutritional requirements. Corn silage contains more digestible energy than hay crop silage but less digestible protein. Therefore, if you substitute hay crop silage for corn silage you should feed more energy in the grain ration, but you may reduce the protein content of the grain ration. (See Leaflet 21135, *Determining the Standing Field Value of Outs and Corn for Silage*.)

Disease Pests

Fungi, bacteria and viruses causing the major oat diseases in California are transmitted from field to field or plant to plant by air, rain water, soil, seed or by insects. Thus, the control often depends upon how they are spread. Many diseases affect wild oats and are spread from them to cultivated oats in many areas.

Stem rust, caused by the fungus *Puccinia grammis* f. sp. *avenae,* is the most common and often most serious disease of oats in California. Since the fungus and spores may be found throughout the year on cultivated oats, wild oats, volunteer oats and other closely related grasses, a source of inoculation for infection is often present when weather conditions favor disease development. Epidemics occur in cultivated oats when temperatures and humidity in late winter and early spring are above the average normal for California oat growing areas. A heavy rust infection will cut grain yield and forage quality severely.

The disease may be recognized by elongated pustules of red spore masses that break through the leaf surface; the result is a ragged margin of host tissue around the spore mass. Infection and population may occur on leaves, leaf sheaths, stems and flowers. These spores are spread by the wind and infect other plants during high relative humidities and warm temperatures. Late in the growing period of the plant, black spore masses may be produced in place of red spores. Control largely depends upon growing resistant varieties.

Crown rust, caused by another rust fungus *Puccinia coronata,* attacks the leaves and occasionally the leaf sheaths, but it does not infect stems. The fungus produces small, orange-yellow spore masses in compact groups. In many years the disease may affect sufficient leaf area to result in loss of hay quality and grain weight.

The black spore stage is found on older leaves, in small pustules covered by leaf tissue. The red spores from wild and volunteer oats constitute the initial source of inoculum for infection of cultivated varieties in the early spring. The practical means of control is to grow resistant varieties.

Loose and **covered smuts** caused by *Ustilago avenae* and *U. kolleri,* respectively, occur sporadically in cultivated oats because of the use of seed treatments and are most common in wild oats. Evidence of smut infection does not occur until heading time, when the fungus produces black spore masses which replace the normal flower parts. The spores contaminate grain from airborne inoculum or during harvest. They germinate when seed is planted and infect the growing point during the early seedling stage. The disease cycle is completed when spores are again produced at flowering time. Because both pathogens are surface contaminating, control is easily accomplished by use of several seed treatment fungicides.

Powdery mildew, caused by *Erysiphe graminis,* occurs sporadically on cultivated oats in California; it also occurs on wild oats throughout the state. It is identified by gray to tan masses of fungus growth on the leaves. Spores produced on this growth are airborne and infect oat foliage during high humidity and cool temperatures. Infection may be severe enough to reduce yield and quality of oat hay. No control measures are practiced.

Victoria blight, a fungus caused by *Helminthosporium victoriae,* has been present in California for many years and reached epidemic proportions in the upper Sacramento Valley in 1956, 1957 and 1958. At present it is rarely found, attacking only oats. It is characterized by red-brown to small purple oval spots on the leaves. As the fungus progresses, the spots become elongated and irregular in outline and light brown in color. Multiple infections result in death of leaves. Infections may reach the upper leaves and floral parts when frequent periods of rain occur through the spring. The primary infection of a plant results from the seedborne phase or from airborne spores produced on refuse from a previously infected crop or on wild or volunteer oats in the immediate area. Rotation with another crop for one year will eliminate most of the carryover on plant refuse in the soil.

Halo blight, a bacterial disease caused by *Pseudomonas coronafaciens,* is common on some varieties. It attacks only oats. Infection occurs on leaves and floral parts resulting in oval spots, at first water soaked, with a yellow margin, and later with a tan center. The bacteria may be carried in crop residue for one year or may be seedborne.

Root rot may be caused by several different soil inhabiting fungi, but oats rarely suffer severely from attack. Wheat and barley are much more susceptible to these fungi. The disease is characterized by brown to black discoloration at the base of the stems. This invasion by the fungi may kill plants at any time in small, scattered spots or in irregularly shaped areas that may be several hundred feet across. Wild oats and other weeds usually grow luxuriantly in such spots. Oats are sufficiently tolerant to attack to be used in rotation where the disease has become a major factor in wheat and barley production. When planted following a year of oats, barley or wheat will often show markedly less root rot than when they follow barley or wheat.

Barley yellow dwarf virus causes disease in wheat, barley, oats and many wild and cultivated grasses. It is transmitted from diseased to healthy plants during the feeding process of any one of several species of grass-inhabiting aphids. Very early (October 1) or very late (February 15) plantings usually are most severely damaged, because aphid populations are generally higher in early fall or late spring. In oats, the disease results in dwarfing and an orange-to-red discoloration of the leaves, in contrast to a yellow discoloration in wheat or barley. The leaf reddening starts at the tips of the older leaves and progresses to the base, with orange-red blotches preceeding the overall reddening. At heading, blasting of basal flowers of the panicles may be evident. When a high incidence of infection occurs during the young plant stage, yields may be reduced by as much as 70 percent.

All varieties are susceptible but Coast Black and California Red are the most susceptible to injury, and some varieties such as Sierra and Curt show tolerance. Kanota is the most resistant variety. Timing the date of planting to avoid high aphid activity and using varieties with some tolerance are the only practical means of control.

Blasted panicles are ones with varying degrees of withered or empty florets. They may result from unfavorable climatic conditions or from BYDV. This condition reduces the number of seeds per head and may reduce yield. Although seen in red oats, the condition is much more common in white seeded varieties imported from cool climates.

Insect Pests

Rarely have insect pests appeared in California oat fields in sufficient numbers to make chemical control economically practicable. Despite the fact that at least five species of aphids transmit yellow dwarf virus, it has rarely paid to control them by chemical treatment. lf insects appear to be damaging your oat crop, ask your local farm advisor whether treatment is necessary.

This information is provided by Cooperative Extension, an educational agency of the University of California and the United States Department of Agriculture. Support for Cooperative Extension is supplied by federal, state, and county governments. Cooperative Extension provides the people of California with the latest scientific information in agriculture and family and consumer sciences. It also sponsors the 4-H Youth Program. Cooperative Extension representatives, serving all counties in California, are known as farm, home, or youth advisors. Their offices usually are located in the county seat. They will be happy to provide you with information in their fields of work.

Issued in furtherance of Cooperative Extension work, Acts of May **8** and lune 30, **1914,** in cooperation with the United States Department of Agriculture, Jerome **B.** Siebert, Director, Cooperative Extension. University of California.

3m – 1/82 – HS/VG

For information about this and other publications, contact

University of California
Agriculture and Natural Resources
Communication Services
6701 San Pablo Avenue, 2nd Floor
Oakland, California 94608-1239

Telephone 1-800-994-8849
(510) 642-2431
FAX (510) 643-5470
E-mail: danrcs@ucdavis.edu
Visit the ANR Communication Services website at http://anrcatalog.ucdavis.edu

An electronic version of this publication is available on the ANR Communication Services Web site at http://anrcatalog.ucdavis.edu.

Publication 21265e

Previous printing 1982. Digitally re-issued 2002; no content was updated from the 1982 printing.