Alfalfa for Hay and Pasture in Southeastern Oregon

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ALFALFA FOR HAY AND PASTURE IN SOUTHEASTERN OREGON

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Alfalfa (*Medicago sativa* L.) has been a major forage crop in the United States for more than 100 years. Alfalfa varieties, however, were not recognized commercially until about 1892. In the 1940s', the breeding and release of improved name varieties were major steps in further recognizing the importance of alfalfa as a forage plant. Since then, the interest of private industry and state and federal experiment stations has increased; many new selections enter the market each year.

Alfalfa, especially adapted to well-drained calcareous soils, is grown widely throughout the intermountain and western states. However, it has specific environmental limitations and definite limits of varietal adaptability.

Until recently, alfalfa production was restricted in Oregon's Malheur-Harney Basin. Because of the arid climate of southeastern Oregon, alfalfa has not produced well, yielding about 0.8 ton/acre annually (Sneva et al., 1964). Wild flooding of the meadowland has raised the water table of irrigated lands. Alfalfa without adequate water control and proper irrigation was not adapted and was not widely accepted as a hay crop. In 1969, 16,000 acres of alfalfa were grown in Harney County; 14,000 acres were irrigated and 2,000 acres were dryland (Oregon State Census of Agriculture, 1969). The total yield of alfalfa hay for the county was 40,500 tons, averaging 2.5 tons/acre. In early research at the former Harney Branch Experiment Station, alfalfa reportedly produced yields of cured hay up to 9.7 tons/acre (Shattuck and Hutchison, 1928). This production was obtained with the Grimm variety harvested in two cuttings. In those early plantings, all alfalfa varieties, including Cossack and Turkestan, produced seven year average yields of more than 6.6 tons/acre.

With the development of irrigation wells and sprinkler systems, large land areas were brought under cultivation, and surveys indicate that in suitability classes I, II, and III, 1.7 million acres could be put into more intensified crop production (Lindsay et al., 1969). In 1967, Squaw Butte Experiment Station initiated forage production and water control studies to determine the adaptation, yielding ability, and management of many alfalfa varieties. This report is a summary of results of these experiments.

MATERIALS, MAINTENANCE, AND PROCEDURES

Location

The studies were done at the winter headquarters of the Squaw Butte Experiment Station, approximately six miles southeast of Burns, Oregon. In its natural state, the site was a wetland meadow subjected to seasonal flooding and a high water table. The soil, generally unclassified but mainly fluventic and cumulic Haplaquolls, is a variant of Damon, Stanfield, and Silvies series, predominantly silt loam in texture, and basic in reaction with pH of 7.5 to 8.5. It was developed from lacustrine sediments of an old lake bed and alluvium deposits from the Silvies River.

The climate is representative of the high desert country in southeastern Oregon. Average annual rainfall is 10 to 12 inches. The growing season averages about 83 days, varying from 20 to 116 days (Gomm, 1979a). The average annual temperature at Burns is about 46°F, with an average daily maximum in July of 86°F and an average daily minimum in January of 16°F (Johnsgard, 1963).

Site preparation

To establish and maintain plantings, it was necessary to lower the water table and remove native vegetation. A trench 12 feet wide and 6 to 10 feet

deep was dug around a 60-acre tract. Water draining into the trench was pumped away from the area to maintain a water table below 36 inches. The meadow sod was broken by plowing in the fall of 1967. The seedbed was prepared by disking and harrowing the following spring. Phosphate fertilizer was applied at 40 pounds P_2O_5/acre and worked into the soil. The field was then planted to barley (*Hordeum vulgare* L.). After the barley was harvested, the seedbed was again worked preparatory to planting in the spring of 1969. Subsequent plantings were made after seedbed preparation in the spring on fall-plowed land.

Planting

Nursery studies: In the spring of 1969, 19 alfalfa varieties were planted using a single row seeder. Rows were spaced one foot apart in 5 X 40-foot plots. The plots were split by fertilizer treatment, and phosphate fertilizer at 40 pounds P_2O_5/acre was randomly applied to half of each plot. Each variety-fertilizer treatment was replicated four times. Plantings made in 1973 and 1976 were made using John Deere flexiplanter drills mounted on a tool bar.[3/] Rows were spaced one foot apart in 5 X 25-foot plots. Twenty-two alfalfa varieties were planted May 30, 1973, in a randomized block design with four replications. In 1976, 22 varieties were planted June 11 in a randomized block design with three replications.

Field plantings: A 14-acre field was planted in 1969 to 'Vernal' alfalfa using a standard grain drill. Rows were spaced seven inches apart. The field was replowed in the fall of 1974, planted to barley in 1975, and replanted to alfalfa and grass mixtures in the spring of 1976 using a Brillion cultipacker seeder. The 1976 planting consisted of Promor alfalfa in pure stand, Promor with Latar orchardgrass (*Dactylis glomerata* L.), Promor with Manchar smooth

3/ Mention of a trademark of proprietary product does not constitute a guarantee or warranty of the product by the U.S. Department of Agriculture of Oregon State University and does not imply its approval to the exclusion of other products that may also be suitable.

bromegrass (*Bromus inermis* Leyss.), Promor with Regar bromegrass (*Bromus biebersteinii* Roem and Schult.), and Promor with Fawn tall fescue (*Festuca arundinacea* Schreb). In the pure stand, alfalfa was planted at 18 pounds/acre. In the mixed stands, Promor was planted at 12 pounds/acre with each grass planted at 10 pounds/acre. Pastures of Vernal alfalfa with Fawn tall fescue also were planted in 1969, and Promor alfalfa (with Latar orchardgrass) was planted in 1976. Grazing response to these pastures in comparison with clover and grass pasture mixtures is presented elsewhere (Gomm, 1979b).

Fertilization

In fertilizer experiments, treble super phosphate was applied in 1972 to provide 0 to 160 pounds P_2O_5/acre in combination with ammonium sulfate to provide 0 pounds S with 0 pounds N/acre or 50 pounds S with 45 pounds N/acre. In 1973, the plots were re-treated at the same rates. Treatments were replicated four times in a randomized block design. In 1974, a new study was established using the same forms of fertilizer but increasing application rates to provide 0 to 600 pounds P_2O_5/acre in combination with 0 pounds N/acre and 100 pounds S with 90 pounds N/acre. Treatments were reapplied at the same rates in 1975.

Irrigation

The plots were irrigated by sprinkling with ground water. Hand-moved lines were used in 1969-1975 and a traveling "big gun" system was used in 1976 and 1977. The sprinkling system delivered about four inches of water per setting with 4 to 5 settings scheduled during the growing season. The first irrigation began in early May. Subsequent applications were at four-week intervals except when varied for experimental purposes or to facilitate the haying operation.

In 1972, the alfalfa field was divided by irrigation treatments into five 2.5-acre plots. Irrigation treatments were: a) no irrigation, b) irrigation only once in September, c) irrigation every 14 days during the hay growing season, d) the same as c) plus an extra setting in September, and e) irrigation every 28 days during the hay-growing season plus an extra setting in September. The irrigation treatments were repeated in 1973 and 1974 on the same plots to determine the accumulation effect over a three-year period.

Soil samples were taken at three sampling points across each irrigation plot. At each sampling point, four samples were composited for pH and salt concentration analyses. Samples were taken at 0-12, 12-24, and 24-36 inch depths.

Analyses of irrigation and drainage water sampled periodically through the growing season showed they contained 0.2 and 0.375 mmhos/cm each year and that the concentrations remained relatively constant through the growing season.

Harrowing

The alfalfa field and nursery sites were harrowed early in the spring to break up and scatter animal droppings and to reduce growth of annual weeds.

Controlled grazing

When plant growth was retarded after killing frost in the fall, cattle were allowed to graze regrowth and clean up fence lines. The cattle were removed to leave a three- to four-inch stubble.

Harvesting

Forage samples were taken of three cuttings. Sampling was done when the alfalfa plants were in the late bud stage, except in 1975, 1976, and 1977 when two cuttings were made when plants were at approximately one-third bloom. Cold May weather delayed plant development in each of these years. After

samples were removed, the study area was cut and harvested in the normal haying operation. Samples were dried at 150°F to determine dry yield and then were ground for chemical analysis.

Sample harvesting in 1970-1971 was done by mowing a 2.5 X 10-foot strip from the center of each plot. In 1972-1977, meter square samples were hand cut from each plot. The number of samples varied with the plot size.

In 1972, a date and stage harvest experiment was established in a randomized block design with four replications. The treatments were:

1. Harvest one cutting during the season.
   Samples were taken from previously uncut herbage at two-week intervals from May 1 to August 25.
2. Harvest two cuttings during the season.
   The first cutting was about July 9 when plants were in the one-third to one-half bloom stage.
   The second cutting was at the end of the season, about August 25.
3. Harvest three cuttings as tillers emerge.
   First cutting--about June 8.
   Second cutting--about July 15
   Third cutting--about August 25
4. Harvest four cuttings (allow 28 days between cuttings).
   First cutting--May 30
   Second cutting--June 28
   Third cutting--July 26
   Fourth cutting--August 25
5. Cut at first sign of breaking into bloom.
6. The first and second cuttings were at one-tenth bloom.
7. The first and second cuttings were at one-third bloom.
8. The first cutting was at one-half bloom.
9. The first cutting was at full bloom.

Regrowth from each treatment was harvested at the end of the season.

The treatments were reapplied in 1973 and 1974 on the same plots. In 1975, all plots were harvested uniformly on June 20 and August 15.

RESULTS AND DISCUSSION

Differences among alfalfa selections became evident when the variety 'Ranger' was first developed. It proved to be an improvement over common alfalfas, but we now have even better varieties. Many of the 46 tested varieties and selections are superior to Ranger in resistance to disease and insect damage (Table 1). Several are more winterhardy (Table 2), and produce more forage (Table 3) than Ranger or Vernal, two standard varieties recommended for the area.

Variety adaptation

Because of problems with the irrigation system in 1970 and 1971, yields from the 1969 plantings were low and do not realistically represent the potential production of these alfalfa varieties (Table 3). However, the production of most varieties increased during the next three years. Several varieties including Culver, DuPuits, Narragansett, Promor, Ranger, Resistador, and Uinta exceeded 5 tons/acre in 1974. Yields generally decreased in 1975 and continued to decline in 1976 and 1977. Yields from the 1973 plantings were generally highest in the first and second years after planting, with many varieties producing more than 5 tons/acre (Table 4). Reduced yields in 1975, 1976, and 1977 were attributed to cold weather during May which delayed plant growth. Only two cuttings of hay were possible in these years and the lowered yields may have been caused by the shortened growing period.

In addition to the harvested hay, about 1 ton/acre of fall regrowth was grazed in 1976 and 1977. The total production, therefore, appeared to be about constant for 1974-77.

Yields from the 1976 planting (Table 5) were relatively high compared to the 1977 yields from the 1969 (Table 3) and 1973 (Table 4) plantings. With the addition of the fall regrowth, most varieties would have produced more than 5 tons/acre.

It appears that good yields can be produced in the first year after planting, but maximum production will be obtained three to five years after planting. Without renovation, it is expected that production would decline after the fifth year.

Narragansett was specifically developed for soils with a high water table, but other varieties equaled it in production. The decumbent growth habit of Nomad, Rambler, and Spredor, their root-spreading characteristics, and slow growth after cutting should make them desirable for pasture plantings.

Disease

The study site appeared to be free of disease, and no evidence of bacterial-diseased plants was observed. The similarity in yields of most varieties after eight years of production (Table 3) indicates that bacterial wilt [*Corynebacterium insisiosum* (McCull.) H. L. Jens.] was not a problem. Even the most susceptible varieties, Grimm, Narragansett, and DuPuits, continued to be among the best producers. This, however, does not preclude that this or other diseases are not present in the area since alfalfa never had grown on the study site or surrounding meadows. If a particular disease is thought to be active, it is advisable to consider growing a resistant variety (Table 1).

Moapa 69, a non-hardy variety, is the only variety tested which cannot be recommended for southeastern Oregon. In the seedling year, it grew fast and produced more herbage than other varieties, but many plants winterkilled. Moapa 69 could be planted as a green manure crop but it cannot be recommended as a semi-permanent hay crop. Yields of Brand 919, a blend of alfalfa varieties, also declined rapidly in the second and third years after planting. It appears that this blend contains a non-hardy variety.

Insects

Alfalfa weevil (*Hypera postica* Gyllenhal) and spotted alfalfa aphid [*Therioaphis maculata* (Buckton)] are important insects found in alfalfa fields of southeastern Oregon. Heavy infestations of weevil were noted in 1974-1977 in the field of Vernal alfalfa but damage was minimal to varieties in the adaptation studies. Weevils were present on all varieties and did most damage on the first cutting. Only a few weevils were found on the second cutting. Weevil damage became noticeable about the time the alfalfa plants were in the late bud stage of development. Harvesting the hay at that time eliminated the need to spray for weevil control.

Spotted alfalfa aphid was most prevalent in 1974 on the second cutting. No attempt was made to chemically control the insect.

Irrigation requirement

The water requirement of the alfalfa (approximately 0.25 inch per day or 10 acre-inches/ton of hay) was met with ground water. Alfalfa producing 4 to 5 tons/acre requires 40 to 50 acre-inches per growing season. Where the water table was high (3 feet deep) one irrigation of 3.5 to 4 inches of water per cutting was adequate for alfalfa.

The irrigation treatment in 1972 appeared to have no effect on the amount of hay produced. Production in 1972 ranged from 5.6 to 6.2 tons/acre with no significant effect of water application (Table 6). In 1973, differences in yields because of treatment again were not significant in the first cutting, but in the second and third cuttings, yields were significantly higher in plots that received water at two- and four-week intervals than in the non-irrigated plot and the plot which had received a single irrigation the previous September (data not shown). In 1974, the highest yields in all three cuttings were produced when water was applied at 28-day intervals (Table 7). The lowest yields were produced when water was applied at 14-day intervals.

Soil pH did not change significantly as a result of irrigation treatments (Table 8), but the concentration of total salts did change. When irrigation water was withheld, salt concentrations increased at all depths to 36 inches, and they generally increased each succeeding year. When water was applied only once in the late fall, the salt concentration remained approximately constant. Water applied throughout the summer at 2- or 4-week intervals generally lowered concentrations at all depths in each succeeding year.

It appears from results of this study that when the water table is high, irrigation water should not be applied until the water table drops to below 3.5 feet. This occurred about two weeks after water was withheld from surrounding meadows.

Dandelions (*Taraxacum officinale* Weber) became a serious problem in the alfalfa field. Infestation was heaviest in plots most frequently irrigated. In 1974, reduced yields of plots irrigated at two-week intervals were attributed to the dandelion population and to the weakened over-irrigated plants.

Fertilization of alfalfa

It has been determined that one ton of alfalfa hay will take nutrients from the soil in the following amounts: 50 pounds N, 5 pounds P, 50 pounds K, 35 pounds Ca, 6 pounds Mg, and 5 pounds S in addition to smaller amounts of minor elements (Rhykerd and Overdahl, 1972). Chemical analyses of alfalfa harvested at different lengths of growing period showed that as maturity advanced, the concentrations of N, P, K, Mg, Mn, Zn, Cu, and Mo declined (Tables 9, 10). Calcium and cobalt remained fairly constant with maturity. The levels of nutrient concentrations generally were within the recommended level for a 600-pound animal gaining 2 pounds/day. The phosphorus level, however, may have been slightly deficient after mid-July. The nutrient levels in the plants throughout the growing season also generally were above the concentrations considered adequate for most higher plants (Table 10).

The addition of P, S, and N as fertilizer had no significant effect on the yield of alfalfa herbage (Tables 11, 12). It appears that these elements were sufficiently plentiful in the soil to meet the growth requirements of alfalfa.

Alfalfa for hay

Alfalfa is the main legume fed to livestock in western United States. Native meadow is the primary source of hay for wintering beef cattle in southeastern Oregon, but alfalfa hay, an important cash crop, is sold to dairy producers in California and western Oregon. The hay market demands high quality hay with high protein content.

Alfalfa planted in pure stands will yield about as much as a mixture of alfalfa and grass (Table 13). Total production, however, varies with the grass species. A mixture of alfalfa and a grass that recovers rapidly after cutting or grazing often will produce more than alfalfa alone and generally

will produce more forage than the grass planted alone (Tables 13, 14). Protein yields, however, may be decreased because of the lower protein concentration in alfalfa-grass mixtures.

Climate limits the number of cuttings of alfalfa hay to no more than three. Harvesting should occur when the hay contains a high concentration of feed nutrients, when forage yields are high, and when the roots contain a high level of carbohydrate reserves (Smith, 1972). This normally occurs when the plants are in the one-tenth bloom stage. Alfalfa harvested at the pre-bud stage of development contains a high concentration of feed nutrients, but yields are low and plants are weakened.

The protein concentration in alfalfa normally is very high early in the growing season and in immature regrowth. In uncut herbage, the protein level decreased as maturity advanced through the season (Figure 1). Dry matter and total protein yields, however, increased. In our experiments, dry matter yield increased until about July 20 and then decreased until August 1 when it increased again (Figure 2). The sudden decrease about July 20 coincided with a major loss of lower leaves. The increased yield after August 1 was attributed to the new growth of tillers which more than compensated for the loss of leaves from the early plant stems. Total protein yield followed a production pattern similar to that of dry matter, but the decrease in total protein began about July 5. Protein yield then decreased until August 1 as lower leaves died and were lost. It appears that to harvest the greatest amount of protein, the first cutting of hay should be no later than July 5.

Our experiments showed that the highest dry matter yields were produced when alfalfa was harvested twice during the season (Table 15). Maximum protein production also was highest when the hay was harvested twice, but the feeding

value was lower if the hay was cut when the alfalfa plant was in bloom. Three cuttings slightly reduced total yields of dry matter and protein, but the crude protein concentration was considerably higher than it was in hay cut at later stages of growth, and the total feeding value of hay harvested in the bud stage was greater than that of hay harvested when alfalfa was in bloom.

Cutting four times during the season reduced yields and lowered plant vigor. Protein concentration and the feeding value of the hay were increased (Table 16). The decrease in total production also decreased the total protein produced and the total forage feeding value. In 1974. The vigor of alfalfa plants harvested four times was poor and plots were heavily infested with annual weeds, especially cheatgrass brome (*Bromus tectorum* L.). Three cuttings did not reduce the stand or plant vigor.

In 1975, all study plots were harvested uniformly in two cuttings. Yield results show that the four-cutting schedule had reduced the producing property of the stand (Table 17). Differences among the other cutting treatments were not significant and cutting only once during the season had no yield advantage over alfalfa cut twice or three times during the season.

Alfalfa for pasture

Alfalfa is an excellent pasture species despite its bloat hazard. The incidence of bloat is decreased by planting it in a mixture with grass, by limiting grazing, and by the use of Poloxalene, a chemical agent that prevents the formation of bloat-causing froth (Acord, 1970).

In mixtures with grass, alfalfa can still cause bloat but varieties such as Nomad, Rambler, Culver, and Ladak, which are slower to recover after cutting or grazing and which are decumbent (Table 2), are preferred for pastures. These varieties, in mixture with fast-recovering grass species such as

orchardgrass and tall fescue, give a better balance of forage and reduce the danger of bloat. For bloat control, the alfalfa content of the grass-legume mixture should be no more than 40 percent.

Poloxalene, an effective bloat suppressent, is marketed as a medicated pre-mix containing 53 percent Poloxalene. It is fed with grain supplement or in salt blocks. It is important that each animal receive 1.5 grams of Poloxalene per 100 pounds of body weight per day (Acord, 1970). The presence of Poloxalene-salt blocks in the pasture is no assurance that each animal receives the required amount for protection.

Alfalfa should not be grazed in the year of establishment until after a killing frost in the fall. Grazing in subsequent years also should be discontinued for two weeks preceeding the expected fall killing frost to allow for storage of carbohydrate reserves in the root. If root reserves are depleted by continuous grazing, winterkilling of the plant may occur. Regrowth can be grazed to leave a 3.5- to 4-inch stubble after plant growth has slowed after frost.

Alfalfa-tall fescue pastures were most effectively utilized by grazing 14 days in a 28-day rotation period (Gomm, 1979b). Shorter grazing and longer recovery periods may have been better for the alfalfa, but the fescue plants became less palatable and yearling stock gained less when the pastures were allowed 21 days to recovery. The 14-day grazing - 14-day recovery period did not reduce the alfalfa stand appreciably. The legume content of the forage remained about 20 percent throughout each grazing season from 1972 to 1977 (Gomm, 1979b).

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Table 1. Resistance to major disease and insects of alfalfa varieties tested in southeastern Oregon, 1969-1977

Variety	Bacterial wilt	Phytophthora root rot	Anthracnose	Common leaf spot	Downy mildew	Black stem	Alfalfa weevil	Potato leaf hopper	Pea aphid	Spotted alfalfa aphid	Root rot nematode	Stem nematode
Very hardy to hardy northern varieties												
Agate	VR	R		R						S		
Apollo	VR	R	T		S			T				
AS-63	R			T								
Culver	R			MS				MS		MR		
Grimm	S											S
Iroquois	R											
Ladak	R		S	R					S	S		S
Narragansett	S				R							
Orenberg												
Polar 1	R	T		R						S		
Ranger	R	T		S	T	S		S	S	S	S	S
Teton	MR			R		MR						
Uinta	R			R	R					S		S
Valor	R		MR					T	R			
Vernal	VR	S	MS	MS	MS		MS	MR	VS	S	MS	S
Hardy to moderately hardy mid continent & Flemish varieties												
Action	R			R								
Apalachee	S		MR	T			S					
Atlas	VR	S	R		R			T				
AS-49	R	MR		T	MR					R		R
Beltsville 72	R		R	R	MS							
Cayuga	R											
DuPuits	S		VS	R	T	T			MT	S	T	S

Table 1. cont'd

Variety	Bacterial wilt	Phytophthora root rot	Anthracnose	Common leaf spot	Downy mildew	Black stem	Alfalfa weevil	Potato leaf hopper	Pea aphid	Spotted alfalfa aphid	Root rot nematode	Stem nematode
Gladiator	VR	T	T	R			T		VR	MS		MR
Haydak												
Haymaker (Blend)												
K4-120												
Lahontan	R	MR	VS	T	R		VS		S	R		R
Lancer	R	R					T	T	T	MT		S
Marathon	R							T				
N7-5	MR						R					
Olympic	VR	S	R		R			MR				
Pacer	VR	T							R			
Promor	R	S	MR	T	T				T	S		
Resistador	R			MR	R				T	R		T
Saranac	R	S	S	R	R	T		S	S	S	S	S
Team	S		MR	MR		MR	MR		VR	S		MS
Thor	VR	S	VS	R	R	T			S	S		S
Victor	R	S	R		MR			T				
Washoe	R	T	VS	MS	S				R	R	S	R
WL 303	MR								S	S		S
622												
919 (Blend)	VR			T								S
					Hardy creepers							
Nomad	S								S	S		S
Rambler	MR											
Spredor	VR			MR					S	S		S
					Non-hardy southern variety							
Moapa 69	MS	S		S	S				S	R		S

VR=very resistant; R=resistant; MR=moderately resistant; T=tolerant; MS=moderately susceptible; S=susceptible

Table 2. Winterhardiness, fall growth habit, and rate of recovery after cutting of alfalfa varieties planted

Variety	Planting[1/]	Winter-hardiness[2/]	Growth habit[3/]	Rate of recovery after cutting[4/]
		Very hardy to hardy northern varieties		
Agate	2	+	5	3
Apollo	3	=	4	3
AS-63	1	+	5	5
Culver	1,3	+	6	6
Grimm	1,3	+	5	2
Iroquois	3	+	4	3
Ladak 65	1	+	6	5
Narragansett	1,2	+	4	4
Orenberg	2	+	7	6
Polar 1	2,3	=	4	3
Ranger	1	Check	5	2
Teton	1	+	5	4
Uinta	1	-	5	4
Valor	2,3	=	5	4
Vernal	1,2,3	+	5	4
		Hardy to moderate hardy mid-continent & Flemish varieties		
Action	2,3	=	5	3
Apalachee	2	=	4	4
Atlas	3	=	3	3
AS-49	1	=	4	3
Beltsville 72	2	=	4	4
Cayuga	1	=	4	3
DuPuits	1,2	=	2	2
Gladiator	2	=	4	3
aydak	3	=	3	3

Table 2. cont'd

Variety	Planting[1/]	Winter-hardiness[2/]	Growth habit[3/]	Rate of recovery after cutting[4/]
Haymaker (blend)	2,3	=	5	3
K4-120	3	=	4	4
Lahontan	1,2	=	2	2
Lancer	3	=	4	4
Marathon	3	=	2	2
N7-5	2	=	4	4
Olympic	3	=	4	3
Pacer	3	=	4	2
Promor	1,2,3	=	3	3
Resistador	1,3	-	2	2
Saranac	2	-	3	2
Team	2	=	4	3
Thor	2,3	-	2	2
Victor	3	=	4	4
Washoe	2	=	1	2
WL303	1	-	3	3
622	3	=	4	4
919 (blend)	2	-	2	2
		Hardy Creepers		
Nomad	1	=	8	8
Rambler	1	+	7	8
Spredor	2	-	6	4
		Nonhardy southern varieties		
Moapa 69	1,2	-	1	1

1/ 1=planting date: 1=1969, 2=1973, 3=1976. 2/ -less, = equal, + more than Ranger.
3/ Rate on basis of 1=erect and 9=prostrate. 4/ Rate on basis of 1=fastest and 9= slowest to grow after cutting.

Table 3. Annual yields of alfalfa varieties from 1969 planting, 1970-1977

Variety	Hay yield, ton/acre[1/]								
	1970	1971	1972	1973	1974	1975	1976	1977	Avg
AS-49	1.7	2.9	4.3	4.1	5.2	4.2	3.1	2.5	3.5
AS-63	2.1	3.1	4.5	4.3	4.5	3.7	4.1	3.0	3.7
Cayuga	2.2	3.2	4.6	4.5	5.4	4.0	4.8	3.5	4.0
Culver	1.5	3.2	4.0	3.8	5.6	4.9	3.5	3.5	3.7
DuPuits	2.7	3.1	3.6	3.6	5.7	5.0	3.7	2.9	3.8
Grimm	2.6	3.2	4.5	4.4	5.3	4.9	3.9	2.6	3.9
Ladak	2.2	3.2	4.2	4.6	4.0	4.5	3.6	3.0	3.6
Lahontan	2.3	2.6	4.5	4.2	4.7	3.6	2.8	1.7	3.3
Moapa-69	0.9	2.1	2.5	2.2	1.4	1.9	1.7	1.3	1.9
Narragansett	1.9	3.6	4.7	4.3	5.6	3.6	5.3	3.9	4.1
Nomad	2.0	3.1	3.5	3.0	3.5	3.9	2.8	4.2	3.2
Promor	2.2	3.3	4.5	5.0	5.5	4.7	4.2	3.4	4.1
Rambler	1.1	3.0	3.6	3.6	3.9	3.0	2.7	3.2	3.0
Ranger	2.0	3.2	4.1	4.5	6.0	4.5	4.5	3.0	3.9
Resistador	1.6	3.1	4.2	4.9	6.1	5.0	4.1	2.4	3.9
Teton	2.5	3.2	4.0	4.5	4.8	4.4	4.0	3.5	3.9
Uinta	2.4	3.2	3.8	4.6	5.6	4.6	4.3	3.2	4.0
Vernal	1.6	3.1	4.2	4.1	4.7	3.8	4.4	3.1	3.6
WL 303	2.0	3.4	4.5	4.7	4.8	4.2	4.0	3.6	3.9

1/ Low yields in 1970 and 1971 may be attributed to improper irrigation because of a faulty irrigation system.

Table 4. Yield of alfalfa varieties from 1973 planting[1/]

Variety	Hay yields, ton/acre				
	1974	1975	1976	1977	Avg.
Action	5.9	4.7	5.8	4.8	5.4
Agate	5.0	4.8	5.2	4.1	4.8
Apalachee	6.1	5.4	4.6	3.8	5.0
Beltsville-72	5.9	5.4	5.2	4.2	5.2
DuPuits	5.4	5.3	4.8	4.1	4.9
Gladiator	5.6	4.5	4.5	4.5	4.8
Haymaker	5.8	4.1	5.0	4.3	4.8
Lahontan	5.1	3.9	4.1	3.6	4.2
Moapa-69	2.6	3.6	2.3	1.8	2.6
Narragansett	6.2	4.3	4.5	4.5	4.9
N7-5	5.3	4.6	4.7	4.4	4.7
Orenburg	4.9	4.9	4.3	4.0	4.5
Polar (P-18)	5.7	6.1	5.5	4.5	5.4
Promor	5.6	5.6	5.0	4.1	5.1
Saranac	5.4	5.2	4.8	4.1	4.9
Spreador (K8-607)	5.3	5.2	4.7	4.3	4.9
Team	5.3	4.9	4.8	4.2	4.8
Thor	6.0	5.8	5.2	4.3	5.4
Valor	5.6	4.5	5.3	4.8	5.0
Vernal	5.1	5.6	4.7	4.3	5.0
Washoe	5.0	4.5	4.4	4.2	4.5
919 Brand	5.1	2.8	2.6	3.9	3.6

1/ Yields in 1974 were from 3 cuttings, 1975, 1976, and 1977 from 2 cuttings; average of 4 replications; additional regrowth was grazed in the fall of each year.

Table 5. Yield of alfalfa varieties from 1976 planting, 1977

Variety	Hay yield by cutting dates, ton/acre 6/23	8/10	Total Yield
Action	2.8	1.5	4.3
Apollo	2.9	1.8	4.7
Atlas	2.7	1.8	4.5
Culver	2.9	1.2	4.1
Grimm	3.2	1.6	4.8
Haydak	3.2	1.9	5.1
Haymaker	2.9	2.1	5.0
Iroquois	3.1	2.0	5.1
K4-120	2.6	2.1	4.7
Lancer	3.2	1.6	4.8
Marathon	2.9	1.9	4.8
Olympic	2.8	2.1	4.9
Pacer	3.2	2.2	5.4
Polar	2.5	2.0	4.5
Promor	2.4	1.8	4.2
Resistador	2.4	1.8	4.2
Thor	2.8	2.4	5.2
Valor	3.0	2.2	5.2
Vernal	3.0	2.0	5.0
Victor	3.2	2.1	5.3
622	3.0	2.0	5.0

Table 6. Hay yields of alfalfa as affected by irrigation water applications

Irrigation treatment	Hay yield, ton/acre		
	1972	1973	1974
No irrigation	5.8	4.0	3.6
Flush only in September	5.6	3.5	4.0
Four week interval - flush	6.2	5.7	4.8
Two week interval	5.7	4.3	3.2
Two week interval - flush	5.9	4.9	3.0

Table 7. Yield of alfalfa hay as affected by irrigation treatments, 1974

Treatment	Hay yield by cutting date, ton/acre 6/5	7/1	8/21	Total
No supplemental water	1.4	1.1	1.1	3.6
Flush only in fall	1.7	1.0	1.3	4.0
Irrigate at 28-day interval - flush	1.9	1.3	1.6	4.8
Irrigate at 14-day interval - flush	1.3	0.9	0.8	3.0
Irrigate at 14-day interval - no flush	1.3	1.1	0.8	3.2

Table 8. Soil pH and salt values as affected by irrigation treatments

Treatment and soil depth in inches	pH values			Total salts in mmho/cm		
	1972	1973	1974	1972	1973	1974
No irrigation:						
0-12	8.6	8.2	8.5	1.66	2.89	2.71
12-24	8.4	8.2	8.5	0.74	1.33	1.46
24-36	8.3	---	8.2	0.48	----	1.52
Flush only in September						
0-12	8.6	8.5	8.6	1.94	1.31	2.07
12-24	8.4	8.4	8.4	1.23	1.59	1.05
24-36	8.3	---	8.1	0.59	----	0.63
Four week interval-flush						
0-12	8.8	8.6	8.6	1.57	1.30	1.15
12-24	8.4	8.5	8.7	1.33	1.06	0.96
24-36	8.5	---	8.4	0.84	----	0.61
Two week interval						
0-12	8.8	8.5	8.5	1.82	1.30	1.16
12-24	8.4	8.5	8.8	1.45	1.08	0.76
24-36	8.4	---	8.6	0.79	----	0.59
Two week interval-flush						
0-12	8.7	8.5	8.5	1.65	1.07	1.18
12-24	8.6	8.7	8.9	0.92	0.70	0.81
24-36	8.5	---	8.8	0.63	----	0.59

Table 9. Concentration of nutrients in alfalfa cut on one date (August 13, 1972) as affected by maturity

Date of last previous cutting	Age	Nutrient concentration									
		N	P	K	Ca	Mg	Mn	Zn	Co	Cu	Mo
	days	%	%	%	%	%	ppm	ppm	ppm	ppm	ppm
7/27	20	4.66	0.48	3.23	1.91	0.37	35	34	1.2	12.3	15.0
7/21	26	3.47	0.36	3.42	1.80	0.38	28	29	0.9	9.8	13.0
7/10	37	3.10	0.32	3.36	1.85	0.32	26	26	0.8	8.6	13.2
7/6	41	2.80	0.28	2.86	1.81	0.30	27	19	1.0	8.0	12.7
6/28	49	2.82	0.24	2.66	1.81	0.28	24	19	1.0	7.0	8.1
season		2.03	0.16	1.58	1.85	0.26	25	14	1.4	6.2	8.8

Table 10. Concentration of nutrient elements in alfalfa as affected by length of growing period, 1972

Date harvested	Nutrient concentrations									
	N	P	K	Ca	Mg	Mn	Zn	Co	Cu	Mo
	%	%	%	%	%	ppm	ppm	ppm	ppm	ppm
5/1	4.66	0.25	2.45	1.79	0.29	19	35	0.5	11.4	8.0
5/16	3.50	0.24	3.53	1.42	0.30	19	38	0.1	6.2	11.0
5/30	3.31	0.39	3.50	1.72	0.26	22	30	0.6	10.6	5.6
6/20	2.66	0.20	2.20	1.33	0.24	8	13	0.4	7.2	3.7
7/6	2.27	0.23	1.78	2.34	0.25	13	21	1.6	5.0	7.2
7/21	1.95	0.16	1.73	2.12	0.22	11	17	0.4	5.6	6.0
8/15	1.95	0.15	1.53	1.75	0.21	10	17	1.2	8.8	3.9
8/25	1.90	0.14	1.20	2.00	0.21	9	19	1.6	8.6	5.3
Recommended level for 600-pound cattle gaining 2 pounds/day[1/]	—	.19 .22	.6 .8	.25 .27	.03 .07	1 10	10 30	.1 .3	6 10	2 20
Concentrations considered adequate for most plants[2/]	1.5	0.2	1.0	0.5	0.2	50	20	-	6	0.1

1/ Low and high recommendations from several sources.

2/ Salisbury and Ross, 1969.

Table 11. Hay yield of alfalfa in response to P, S, and N fertilization in first cuttings, 1972-1974

P_2O_5	S	N	Yield of first cutting, ton/acre		
			6-23-72	6-7-73	6-27-74
----pound/acre----					
0	0	0	2.2	2.2	1.9
40	0	0	2.4	2.1	2.0
80	0	0	1.9	2.4	1.9
160	0	0	2.0	2.0	1.9
0	50	45	2.2	2.3	2.1
40	50	45	2.3	2.3	2.0
80	50	45	2.1	2.1	2.1
160	50	45	2.2	2.1	2.0

Table 12. Yield of alfalfa fertilizer with P, N, and S, 1974-1975

P_2O_5	S	N	Hay yields, ton/acre 1974	1975
-------pounds/acre-------				
0	0	0	5.6	4.2
150	0	0	5.8	4.7
300	0	0	5.4	4.3
600	0	0	5.7	4.3
0	100	90	5.5	4.6
150	100	90	5.8	4.7
300	100	90	5.9	4.4
600	100	90	6.2	4.8

Table 13. Hay yield of alfalfa in pure stand and in mixture with tall fescue planted in 1969

Species	Forage produced in years, ton/acre				
	1970	1972	1973	1975	1977
Vernal alfalfa	4.1	5.7	4.2	3.7	3.3
Fawn tall fescue	2.6	3.7	3.2	3.1	3.0
Alfalfa and tall fescue	7.2	6.3	4.2	4.0	-

Table 14. Herbage yield of alfalfa and grasses alone and in grass-alfalfa mixtures planted in 1976

Species and mixtures	Hay yield by cutting date, ton/acre						Total for year
	June 27, 1977			August 10, 1977			
	Alfalfa	Grass	Total	Alfalfa	Grass	Total	
Alfalfa (Promor)	3.3	-	3.3	2.1	-	2.1	5.4
Alfalfa-smooth brome	3.8	0.3	4.1	1.7	0.1	1.8	5.9
Alfalfa-orchard grass	2.7	0.4	3.1	1.8	0.1	1.9	5.0
Alfalfa-tall fescue	3.3	0.5	3.8	1.4	0.2	1.6	5.4
Alfafa-regar brome	3.3	0.3	3.6	1.9	0.1	2.0	5.6
Manchar brome	-	5.2	5.2	-	0.9	0.9	6.1
Latar orchardgrass	-	2.8	2.8	-	0.8	0.8	3.6
Fawn tall fescue	-	2.7	2.7	-	0.8	0.8	3.5
Regar brome	-	4.8	4.8	-	0.8	0.8	5.6

Table 15. Alfalfa hay yields as affected by stage and date of cutting

Harvesting treatment and cutting dates	1972	1973	1974
	--------ton/acre------		
One cutting (maximum yield)	5.6	4.1	3.7
Two cuttings (7/10, 8/24)	6.6	5.8	4.9
Three cuttings (6/5, 7/15, 8/24)	5.7	4.8	4.8
Four cuttings (5/30, 7/2, 7/31, 8/24)	5.4	4.2	3.7
First bloom (6/21, 7/31, 8/24)	6.2	5.0	4.9
1/10 bloom (6/28, 8/17)	7.0	5.6	4.9
1/3 bloom (7/6, 8/24)	7.2	5.8	5.1
1/2 bloom (7/10, 8/24)	6.6	5.5	5.1
Full bloom (7/21, 8/24)	6.7	5.1	4.8

Table 16. Yield, protein concentration, and feeding value of alfalfa hay cut at different stages of growth, 1972

Stage of development	Hay yield	Protein concentration	Protein total yield	Hay:gain ratio
	ton/acre	percent	pounds/acre	
Early bud (4 cuttings/season)	5.4	21	2,120	9.1
First bloom (3 cuttings/season)	5.7	19	2,203	10.3
1/10 bloom (2 cuttings/season)	7.0	18	2,199	13.6
1/3 bloom at 1st cutting (2 cuttings/season)	7.2	17	2,163	-
1/2 bloom at 1st cutting (2 cuttings/season)	6.6	16	1,938	-
Full bloom at 1st cutting (2 cuttings/season)	6.5	12	1,690	-
Single cutting (1 cutting at maximum yield)	5.6	12	1,152	-

Table 17. Hay yield of alfalfa as affected by previous cutting treatments

Previous treatment	Hay yield by cuttings ton/acre		
	6/20	8/15	Total
Harvest 1 cutting at maximum yield	1.8	1.7	3.5
Two cuttings	2.0	1.7	3.7
Three cuttings	1.9	1.6	3.5
Four cuttings	1.2	1.4	2.6
1st bloom	1.7	1.8	3.5
1/10 bloom	1.9	1.8	3.7
1/3 bloom	2.0	1.9	3.9
1/2 bloom	1.9	1.8	3.7
Full bloom	1.9	1.7	3.6

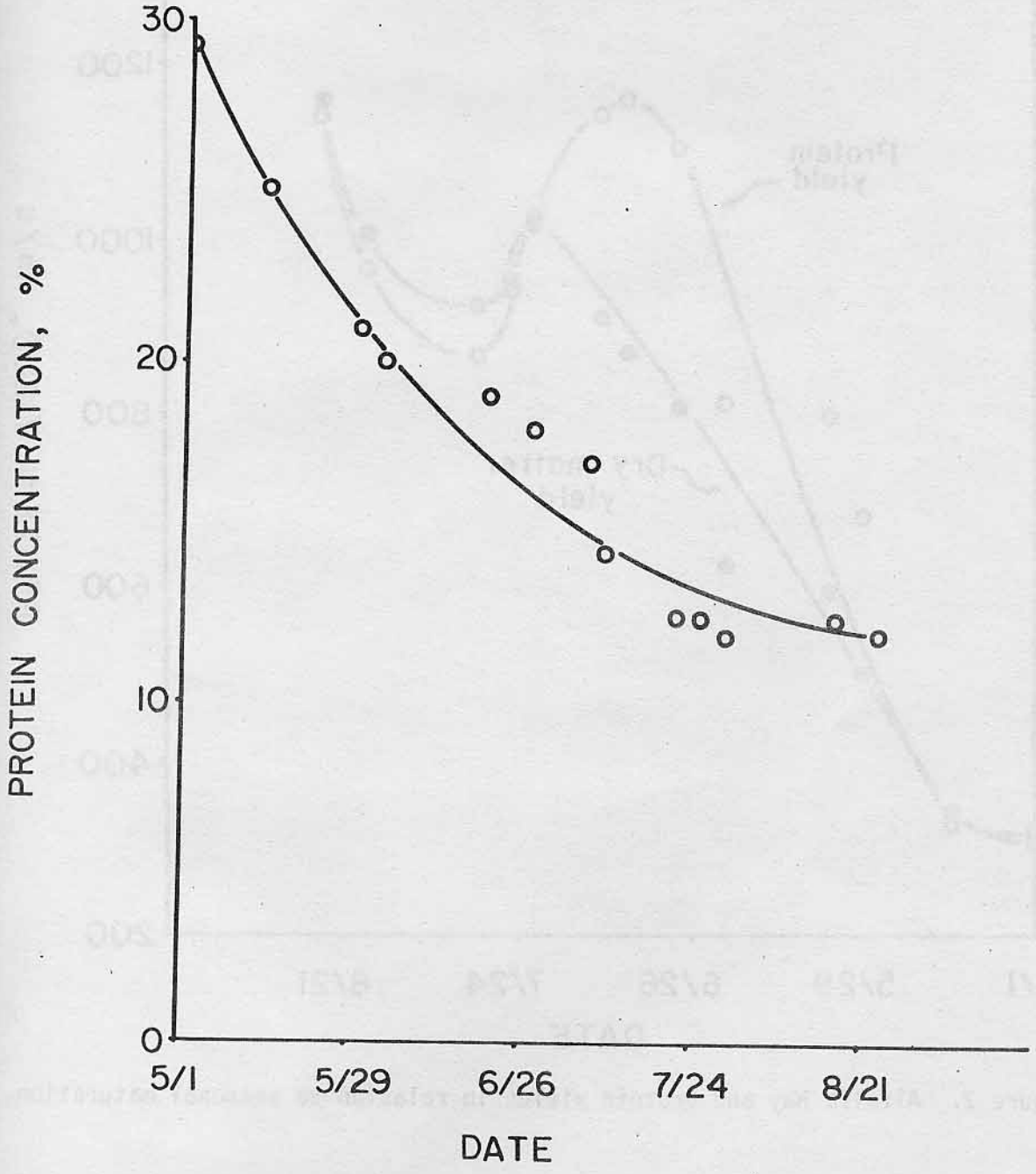

Figure 1. Protein concentration in alfalfa in relation to seasonal maturity.

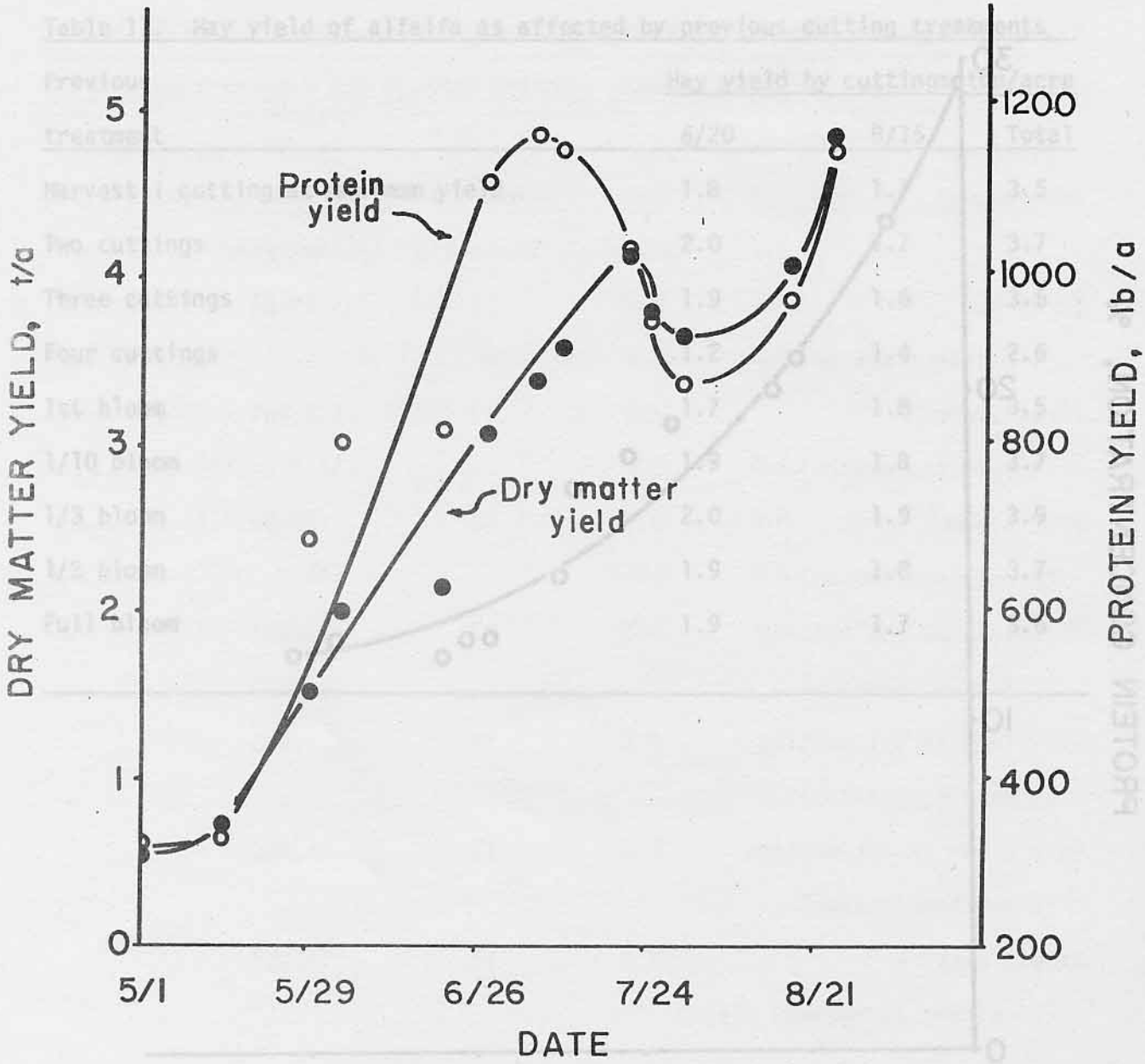

Figure 2. Alfalfa hay and protein yields in relation to seasonal maturation.