

COLOPADO
STATE
UNIVERSITY
EXPERIMENT
STATION
FORT COLLINS
BULLETIN 553S

IN
COLORADO



EXPERIMENT STATION

Colorado State University does not discriminate on the basis of race, color, religion, national origin, sex or handicap. The University complies with the Civil Rights Act of 1964, related Executive Orders 11246 and 11375, Title IX of the Education Amendments Act of 1972, and all civil rights laws of the State of Colorado. Accordingly, equal opportunity for employment and admission shall be extended to all persons and the University shall promote equal opportunity and treatment through a positive and continuing affirmative action program. Complaints should be filed with the Office of Equal Opportunity, Student Services Building.

Greg Hinze¹

**MILLETS
IN
COLORADO**

¹Associate Professor of Agronomy, Colorado State University, located at the U.S. Central Great Plains Research Station, Akron, Colorado.

Revised May 1977

1M



TABLE OF CONTENTS

What is Millet	1
Special Advantages of Millet	2
Uses of Millet	2
Grain Type	2
Hay Type	3
Areas Grown and Acreage	3
Cultural Practices	
Seedbed Preparation and Seeding	3
Fertilizing Millet	4
Harvesting	4
Feeding Millet Hay	5
Diseases and Pests	5
Varieties of Proso Millet	6
Varieties of Foxtail Millet	6
Literature Cited	9
Appendix Table 1	11
Appendix Table 2	11
Appendix Table 3	11
Appendix Table 4	12

WHAT IS MILLET?

Millet, as the term is generally used in Colorado, refers to either of two types of annual, grass-like crops. One type usually is grown for its grain, the other for its forage.

The grain type, proso or proso millet, is known scientifically by its Latin designation, *Panicum milaceum*. In much of northeastern Colorado it is called hershey or hershey millet. Hershey is considered to be the anglicized version of the German word for millet, *hirse*. In other parts of the U.S., proso may be called hog millet or yellow or red hog to describe seed color. In other countries it may be termed broomcorn millet. Proso is the common millet of the Old World where it has been grown since prehistoric times for human use. It probably was first introduced into the U.S. by Russian immigrants (1, 14).

The classification to which proso belongs, *Panicum*, is a large group. Farmers and ranchers of the area know other close relatives of proso, such as *Panicum virgatum*, or switchgrass, a perennial pasture grass well adapted to the sandy soils of eastern Colorado. A weedy relative is ticklegrass or witchgrass, *P. capillare*.



Close-up of the heads of proso millet, showing a contractum type of head (see variety descriptions for information on head type).

Hay or forage millet is foxtail millet, *Setaria italica*. It may be called Siberian, White Wonder, Hungarian, or German millet. At one time these were named varieties, but due to the lack of pure seed sources, these terms now often refer only to seed or plant type, color, or shape. There is, however, an established variety named "German" and several named selections from it. There is also a White Wonder variety.

Two annual weeds of Colorado are relatives of foxtail millet. Yellow foxtail (*Setaria lutescens* or *S. glauca*) and green foxtail or green bristlegrass (*Setaria viridis*) resemble their cultivated relative but are not as vigorous or robust.

The term millet, as used elsewhere in the U.S., refers to several other species. Pearl or cattail millet, classified as

Pennisetum glaucum or *P. typhoideum*, is used extensively in the southeastern part of the U.S. as a forage crop. On a worldwide basis pearl millet is raised on an estimated 45 million acres annually and is one of the major food grains (10). True F₁ hybrid varieties of this type exist, utilizing both genetic and cytoplasmic male-sterility systems. A few of these hybrid varieties have been grown at research centers in eastern Colorado. Some varieties of pearl millet may have potential for southeastern Colorado, but further evaluation is needed before recommendations can be made (see appendix tables for agronomic data).



Pearl millet plants are shown here under dryland conditions at Akron.



The photo above is a close-up of pearl millet heads.

Japanese barnyard millet, or billion dollar grass, designated scientifically as *Echinochloa crusgalli* var. *frumentacea* is another seed and forage millet of limited value to Colorado. It is used as a forage crop occasionally in Pennsylvania, New York, and Iowa (12, 15). In Colorado a close relative, barnyardgrass (*Echinochloa crusgalli*), is a weed found in moist areas.

There are at least two types of millet grown in other parts of the world that are not widely known in Colorado. Finger millet belongs to the *Eleusine* genus and also is known as ragi, birds-foot millet, coracan millet and African millet. The koda millet of India or Ditch millet of New Zealand belongs to the *Paspalum* genus (1).

SPECIAL ADVANTAGES OF MILLET

Greb (8) has studied certain aspects of the water economy of proso millet at Akron. He found proso to have the highest conversion of limited water supplies into grain of any domestic crop known. This was attributed in part to a low straw to grain ratio (1:1 for Common White) and to a small leaf area.

He found that proso grain yields began after only 6 inches of total water use (evapotranspiration) whereas winter wheat, barley, oats and grain sorghum require 9 to 10 inches of total water use before grain production began. A grower, therefore, might expect approximately 2,500 pounds or 45 bushels of millet per acre from 13 inches of water use, 900

pounds or 15 bushels of wheat. This is shown graphically in the following figure.

USES OF MILLET

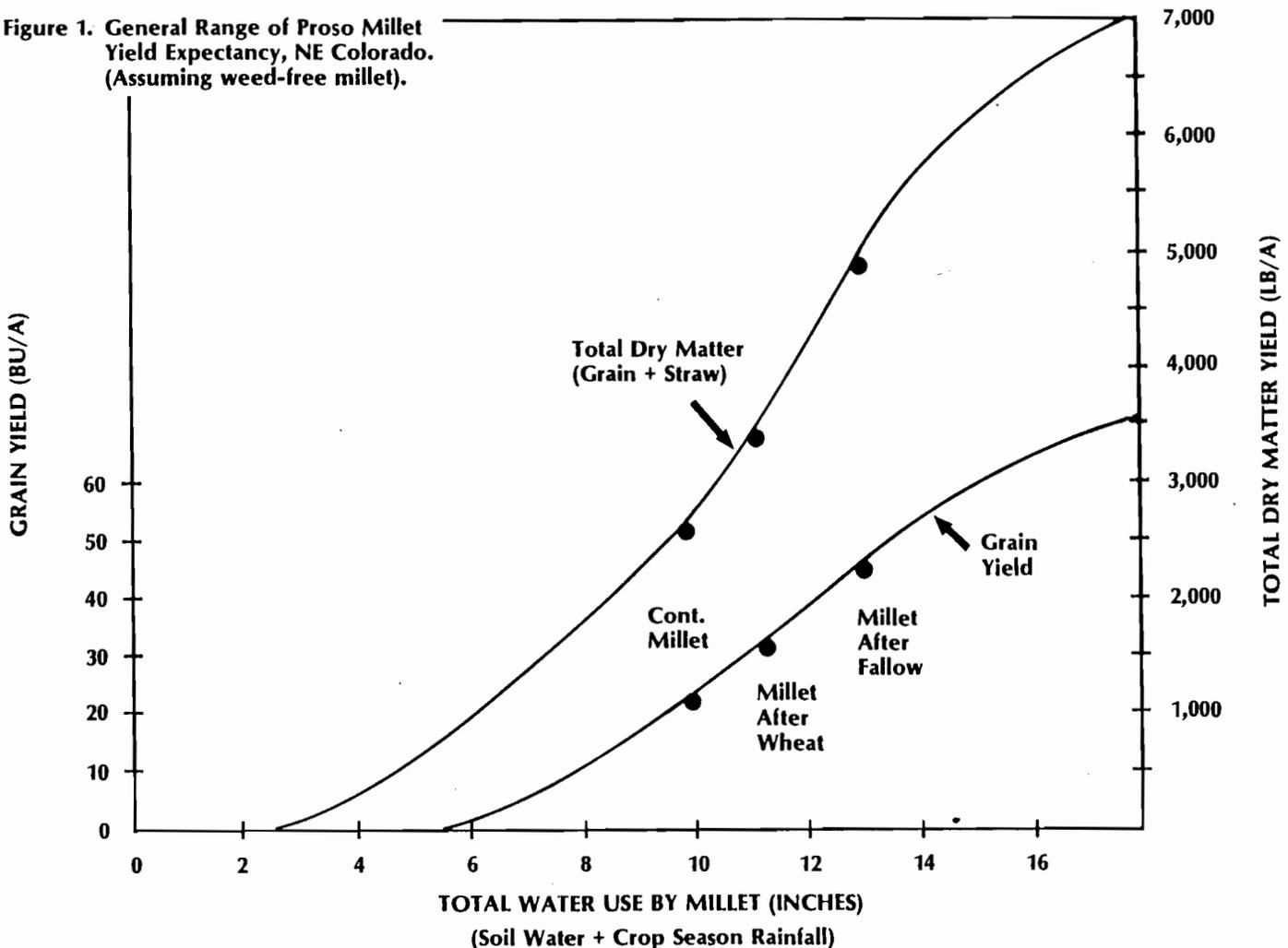
Grain Type

The proso type millet is grown for its grain and used in feeding rations for fowl, cattle, hogs and sheep. It has been reported that some livestock feeders occasionally use a limited amount of proso in their rations because its relatively high oil content enhances pelleting and reduces dust problems in grinding certain grains. Recent data indicate ground or rolled proso is worth about 90 percent of the value of corn for fattening cattle and lambs, from 85-100 percent for swine, and 95 percent for laying hens (6).

Proso should always be ground or rolled for use in feeding all livestock except fowl. Heeney (9) recommends using a 3/32-inch by 1/4-inch screen when grinding proso for hogs to reduce the number of whole kernels. In a feeding experiment with swine, he found proso to be about equal to sorghum in terms of expected gain, but it was not utilized as efficiently as sorghum. Heeney did not use an all-proso ration but substituted various percentages of millet for the sorghum grain (from 25 to 75 percent replacement).

Grabouski and Danielson (7) found that when proso was fed as the only grain to swine, it would nearly equal corn in pounds of pork produced per day per pound of feed if a small amount of L-lysine was added to the ration.

Figure 1. General Range of Proso Millet Yield Expectancy, NE Colorado. (Assuming weed-free millet).



Excellent gains of more than 3 pounds per day on yearling steers were obtained by Denham (4) from a ration of approximately 30 percent proso, 30 percent sorghum and 40 percent wheat. Since the purpose of this experiment was to illustrate the value of locally produced grains, no variation in the relative proportions of these grains was involved.

The grain trade indicates that a large amount of millet now enters the packaged birdseed market. This market prefers the well-colored, bright-seeded proso, although some of the foxtail seed is used in birdseed mixtures. Occasionally a premium is paid for the large, white-seeded or good red-colored millet varieties. Colorado packaging plants operate in Akron, Flagler, Otis and Towner.

Dehulled proso grain can be used for human consumption. It may be consumed unground but processed as "puffed cereal" or cooked as a hot breakfast cereal. When ground, the flour is used as a substitute for a portion of wheat flour in some recipes. It imparts a distinct nut-like flavor to the cooked product which many people find pleasant. A small amount of dehulled proso is used by the health food industry. Leonard and Martin (12) indicate that the chemical composition of millet compared to wheat is as follows:

Commodity	Ave. composition, percent				
	Protein	Fat	Fiber	N-free extract	Mineral matter
Foxtail millet	12.1	4.1	8.6	60.7	3.6
Proso	11.9	3.4	8.1	63.7	3.3
Wheat (all types)	13.2	1.9	2.6	69.6	1.9

Proso straw remaining after threshing may be used for livestock. It is coarse, has few leaves and does not have great feeding value or palatability. The value of this straw is increased if a "buncher" is used on the combine to retain the fine portions of the straw, according to a number of ranchers of the area.

HAY TYPE

Foxtail millet usually is grown for hay. When harvested at complete heading to late bloom stage, it makes a very palatable, leafy hay crop. The grain from foxtail normally is used only for seed purposes, but grain of good color and high test weight also is used as birdseed. Bright yellow foxtail millet seed may be sold as yellow finch millet. As with proso, seed of foxtail millet does not need to be processed when fed to fowl but should be ground or rolled before being fed to other classes of livestock.

AREAS GROWN AND ACREAGE

Available statistics do not specify the Colorado counties in which millet is grown, but northeastern Colorado is the principal area of production. In this area the acreage planted to millet fluctuates widely from year to year since millet is used extensively as a catch-crop to replant fields of winter wheat or winter barley lost to winterkill, soil blowing, drought or hail. In past years the governmental acreage controls of other crops also influenced millet plantings. The following table illustrates the wide fluctuation in millet acreage and production in Colorado as well as the importance of the crop (3).

Year	Acres planted all purposes	Acres harvested for grain	Yield per acre		Pro-duction (1,000 cwt)	Dollar value (1,000)
			(cwt)	(bu.) ¹		
1970	234,000	140,000	10.5	18.8	1,470	2,654
1971	165,000	85,000	10.5	18.8	893	1,786
1972	100,000	40,000	11.0	19.6	440	1,210
1973	90,000	48,000	11.0	19.6	528	3,036
1974	94,000	44,000	7.0	12.5	308	1,863
1975	150,000	105,000	10.0	17.9	1,050	4,620

¹A 56-pound bushel has been used for proso millet (15). The grain trade does not recognize a standard test weight.

The above statistics do not include foxtail millet hay production. The author estimates that foxtail acreage in Colorado approximates proso acreage each year, and that hay yields of 1 to 1.5 tons per year generally are obtained.

CULTURAL PRACTICES

Seedbed Preparation and Seeding

Tillage tools common to the dryland areas of eastern Colorado (one-way disk plow, disk, chisels and sweeps) are used to prepare the seedbed. The exact tool or combination will depend on amount of stubble, weed growth and previous crop. Tillage should be accomplished far enough in advance of planting to permit establishment of a firm, weed-free seedbed. A rod-weeder or mulch-treader should be used immediately prior to planting to destroy all weed growth and to firm the seedbed.

Much millet is grown on summer-fallowed land, especially on heavy soils. It is not known if this is an economic practice. Many growers, especially those on lighter soils, do not summer fallow for millet. Some growers report that millet yields improve under continuous production. Millet is a shallow-rooted crop and probably is not capable of extracting soil moisture below a three-foot depth. Because proso millet leaves the soil subject to wind erosion, growers must use extra precaution to protect the fields such as using wide-spaced chisels to rough up the surface.

Grain drills are used to seed millet. Most growers prefer narrow row spacings of 6 to 8 inches because close spacing provides better weed control than wide spacing. However, millet successfully is grown in 14-inch rows. A shoe or hoe drill will have special advantage only in dry years in putting seed into moist soil.

The following table (6) is presented so that growers may estimate seeding rate. Its use simply involves collecting and counting the seeds dropped from a spout of the drill after running a given distance under field conditions. This table was constructed by assuming 80,000 proso seeds per pound.

Width between rows	Seed per ft. of row			
	15 lb/acre	20 lb/acre	25 lb/acre	30 lb/acre
6"	14	19	23	28
8"	19	25	32	38
10"	24	31	39	47
12"	28	38	47	56
14"	34	44	56	67

A seeding rate of 10-30 pounds of seed per acre is commonly used for both types of millet. These rates are very high, especially considering the fact that a pound of proso contains about 80,000 seeds, or approximately two seeds per square foot when sown at one pound of seed per acre. A pound of foxtail millet seed contains approximately 220,000 seeds (6, 12, 15). Growers consider it so essential to obtain good stands, however, that high rates often are seeded. Millets are relatively poor competitors with weeds and their seedling vigor is low. On heavy soils where crusting often occurs following a rain, fields that receive rain before emergence generally are replanted as soon as field conditions permit instead of waiting to determine stand quality. The use of a rotary hoe to break the crust or to destroy weed seedlings generally is not successful due to the poor vigor and shallow root system of millet.

Experiments in 1969 and 1970 with Leonard proso at the U.S. Central Great Plains Research Station indicate that Leonard will produce good yields at lower seeding rates than those traditionally used for proso. In 1969 plots seeded at 2 pounds yielded as well or better than plots seeded with up to 32 pounds of seed per acre. In a similar experiment in 1970, grain yields of Leonard decreased as seeding rates increased and a rate of 4 pounds per acre gave the highest yield. In the 1970 test, Common White was included at several rates of seeding. Its yield increased with increased seeding rates and was best at the highest rate used, 16 pounds per acre.

Malm and Robison (13) obtained the highest yields of Turghai proso at Alliance, Neb., from a late June planting date and from a seeding rate of 20 pounds per acre, although this rate was not significantly better than a 16-pound rate. Both the 20- and 16-pound rates were better than the 12-pound or lower rates. The soil at that site is a fine sandy loam. There is no indication that any seed treatment was used in these experiments. Brandon et al. (2) obtained good stands from seeding between 12 and 20 pounds of Turghai, but they apparently did not determine yields.

It is evident that no all-inclusive rate recommendation is possible. Drills vary greatly in their ability to distribute the seed evenly and to cover it properly. Soil differences are important and have not been explored sufficiently, but less tillering seems to occur on sandy soils. Seeding rates, therefore, would have to be heavier on sandy soils to compensate for the reduced tillering. Limited experience in Colorado indicates that Leonard should be sown at 4 to 6 pounds per acre on the more fertile soils; the other four varieties described later yield better at higher rates. Common White and Panhandle may require the highest seeding rates.

When growing millet for seed, most growers use the same seeding practice for proso, but foxtail millet often is planted in rows and cultivated. Seeding rates used in row planting are 2 to 4 pounds per acre for both proso and foxtail millet. A few seed growers have found that row culture produces superior seed quality when compared to drilled stands, especially on sandy land.

It has not been common practice to treat millet seed before planting. Limited experience at the U.S. Central Great Plains Research Station has shown that any of several common seed disinfectants such as captan and arasan produce a marked effect on plant count. Stands of 90-95 percent were obtained from treated seeds, but only 40-50 percent stands resulted from untreated seed. The uniformity and vigor of seedlings from treated seed were better than from untreated seed. Seed treatment, therefore, may permit lower seeding rates and promote healthier, more vigorous seedlings.



A field of White Wonder foxtail grown for seed production near Wray, Colorado.

Millet should be seeded into moist soil to insure prompt germination. Seed should not be covered with more than 1 inch of moist soil even on sandy or light soil. Covering depth should be less on heavy soils.

FERTILIZING MILLET

Very little information is available pertaining to fertilizer requirements of millet. It is doubtful that millet would respond to fertilizer of any kind when grown on summer-fallowed land of medium to heavy texture. Grabouski (6) suggests using 20 to 40 pounds of nitrogen when millet is planted into wheat or barley stubble. He also suggests that proso yields will be increased from fertilization if wheat and barley have been found to respond to fertilizer.

Mickelson (16) used rates of 30 pounds of nitrogen in 1968 and 1969 and a 50-pound rate in 1970 on three varieties of proso millet. These were grown on heavy soils at the U.S. Central Great Plains Research Station. The test site was a leveled pan, designed so runoff water from adjacent areas was collected and impounded on the pan. In 1968 and 1969 runoff was collected, whereas in 1970 no runoff was collected on this pan.

As a consequence, the site was partially irrigated in 1968 and 1969 but not irrigated in 1970. Nitrogen increased the dry matter yields of each of the millets in each of the three years, but grain yields were increased by nitrogen only in 1970 and then only on the Leonard variety. Grain yields of the other two varieties in 1970 (Akron and Common White) were actually lower on plots fertilized with nitrogen than on those receiving no nitrogen.

HARVESTING

Harvesting (swathing) of prosos should begin after seeds in the upper half of the panicle have matured. At this stage of maturity the tip seed may have shattered. Cutting too soon reduces yield since seeds toward the panicle base do not fill or mature and test weight is reduced. Early cutting also

impairs quality since it prevents full color development in the seed. In white proso, immature seed will appear as greenish-yellow; in red prosos the immature seeds are an off-white or yellow color. Any millet harvested too early will have a poor test weight.

Foxtail millet hay had the best combination of yield, protein content and *in vitro* dry matter digestibility when harvested at the soft dough stage according to Jennott (11). Greater dry matter yields were obtained with later harvest, but quality declined. If a seed crop is desired, the plant should be left uncut until completely ripe at which time it may be bound or swathed. More and more growers are directly combining foxtail millet soon after a killing frost with slight loss due to shattering.

FEEDING MILLET HAY

Denham and Takeda (5) fed hay of Golden German foxtail millet and Leonard proso to replacement Hereford heifers in 1968. Both varieties were harvested as a hay crop in the late bloom stage of maturity. They reported excellent winter gains with hay of both types of millet but found the foxtail type slightly superior in rate of gain, in palatability and slightly lower in feed cost. Both hays tended to produce lump jaw and sore eyes. The awns of the foxtail millet and the hairs or bristles found on the panicle branches of the proso millet apparently penetrated the mouth tissues and permitted infection to occur. Sore eyes may have been caused by these awns, by hairs or bristles and by the calves feeding from a deep bunk, which exposed their eyes to the forage as they rummaged in the bunk.

Dr. T. D. Hinebauch of the North Dakota Experiment Station studied the effects of feeding foxtail millet hay alone to horses. This work was published in 1896. When millet hay was the exclusive forage for any considerable period of time, a general weakness developed, which later resulted in a softening of bones and an inability to stand. If another forage was substituted, recovery began almost immediately. Returning to the millet hay reversed the recovery process. The injurious effects were noted as (a) producing an increased action of the kidneys, (b) causing lameness and swelling of the joints, (c) producing infusion of blood into the joints and (d) destroying the texture of the bone, rendering it softer and less tenacious, so that the ligaments were often torn loose from the bone and the bones themselves broke easily. The hay may be fed sparingly as a supplement to other forage without detrimental effect to horses. Most of the injury arose from feeding the hay in large quantities with little or no other grain or forage and for extended periods. Cutting stage of the millet did not reduce the damage to horses. However, this hay can be fed to cattle and sheep without danger. Later work resulted in the isolation of a glucoside called Setarian. This chemical, from its action on mice, rats and young cats, was concluded to be the agent causing injury to horses (18, 19).

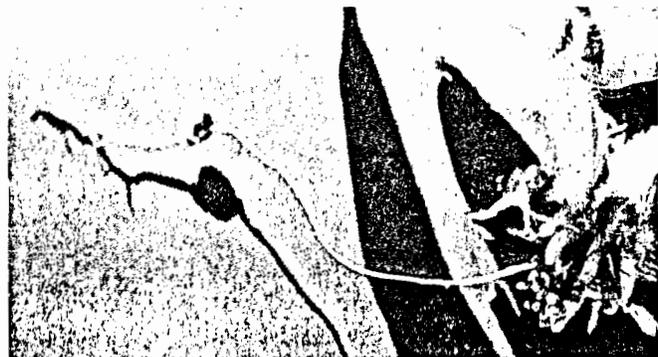
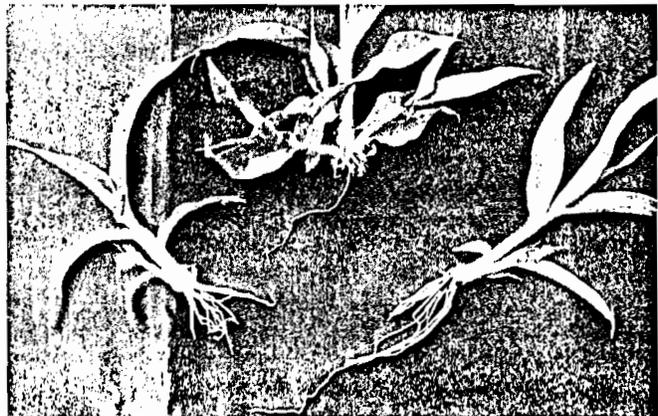
Both immature and overripe foxtail millet hay have been reported to induce abortion in brood mares and cows, but this has not been established experimentally (19). Foxtail at any stage of growth acts as a laxative and diuretic. Hay cut from young plants seems to be most strongly laxative; overripe hay is most diuretic. Cutting at the correct stage of growth, which Williams described as between heading and late-bloom, reduces either effect.

In spite of the reports regarding animal damage from feeding millet hay, a great amount of it is fed throughout eastern Colorado, apparently without any of the detrimen-

tal effects noted in the literature. Millet hay generally is being used in this area to supplement other hays and pasture, so the problems associated with an exclusive diet do not arise.

DISEASES AND PESTS

Both types of millet are remarkably disease-free where grown in Colorado, but the following diseases occasionally may be encountered. Head smut of proso is caused by the organism *Sphacelotheca destruens*. It is easily controlled by treating seed with organic dusts. Kernel smut (*Ustilago crameri*) of foxtail millet is more difficult to control. Control recommendations for kernel smut included crop rotation and seed treatment with a volatile organic mercury compound (6, 12). Neither disease is widespread in Colorado.



Abnormal root development of a proso seedling due to a dry soil layer below the crown node. In the picture on top, the center plant shows the typical club-like secondary roots and the long seminal root from the seed to the crown node. Plants on either side are developing normally. A close-up of the abnormal roots is shown on the bottom.

Prosos apparently do not harbor the wheat curl mite, but foxtail millet is known to host this insect (6, 17). This means that foxtail millet can be a vector for the spread of wheat streak mosaic. Wheat should not be planted immediately adjacent to foxtail millet, especially leeward of the prevailing wind direction. All volunteer foxtail millet should be killed. Cutting foxtail for hay by early August and undercutting the stubble should destroy the crop and thus the continuity of hosts required for the mite, reducing chances for future infection of wheat.

Under certain conditions, proso seedlings are unable to root properly. Although no experimental evidence is available, it

appears that a dry surface soil and perhaps elevated air and soil temperatures are the cause. If dug up, the seedling has the seminal root from the seed to the crown node, and all secondary roots developing from the crown are very short and club-shaped. These secondary roots fail to penetrate the dry soil surface. Millet may be quite sensitive to 2,4-D in this condition. The seedling may continue to grow and, in some instances, even produce some seed. Lodging is extreme. The condition seems to correct itself following a rain.

Many rodents and birds are attracted to millet, especially proso, and can cause great damage in certain years and locations.

VARIETIES OF PROSO MILLET

(see appendix tables for agronomic data).

1. Turghai was the only variety certified by Colorado before 1968. This red- to orange-seeded variety has an open or spreading panicle of the *effusum* type. Plants are mid-tall to tall, ranging from 22-34 inches in height in northeastern Colorado. The glumes of this variety become tinged with purple after flowering so that a field acquires a recognizable color. This variety often can be swathed 60-70 days after planting and is capable of producing good yields of grain with excellent test weights.
2. Common White is the locally grown, large-seeded variety. Origin of the line is unknown. Presently, available seed of this variety is impure and many different types can be found in commercial fields. The predominant type has a *contractum* head; that is, the panicle is not widespread but confined. Open-type heads (*effusum*) also are found in large numbers in commercial fields. Both types tend to have weak straw. Seed color is usually a slight off-white under favorable weather conditions. This variety matures slightly earlier than Turghai.
3. Panhandle is a selection out of Common White made in Nebraska, where it is described as having creamy white seed of average size and high test weight. Heads are semicompact with some tendency to shatter. Stalks are medium in height with fair strength, and they mature relatively early.
4. Akron is a deep red-seeded line released by the Colorado State University Experiment Station in 1969 from material supplied through the Plant Introduction Service of the USDA by the North Platte, Neb., Experiment Station. It originally came from Iran and was designated as P.I. 222811. In yield tests in eastern Colorado, Akron has yielded less grain than Turghai. It was released because its dark red seed color is preferred by the birdseed market. This variety matures two to four weeks later than Turghai in northeastern Colorado. Plants range from 22-44 inches in height and have strong stalks which resist lodging. The primary heads of most plants are of the *compactum* type, very similar to the old "lump" type of millet. Heads on tillers are slightly more open.
5. Leonard is a shiny yellow or tan proso obtained from the Plant Introduction Service of the USDA by the North Platte, Neb., Experiment Station. Leonard was designated as P.I. 223794 in collection. It was collected in Afghanistan and was released to Colorado agriculture in 1968 by the Colorado State University Experiment

Station. This variety has been a consistently high yielder both in northeastern and southeastern Colorado. Plants range from 22-36 inches in height and have fine stems, a profusion of leaves and open (*effusum*) heads. Plants mature two to three weeks later than Turghai or Common White. This variety is especially recommended for growers not producing grain primarily for the birdseed market.

6. Cerise is a red-seeded, open panicle type released by Dr. Len Nelson of Nebraska in 1974. It is similar to Turghai in appearance and growth pattern.
7. Abarr is a selection out of Common White, released by the Colorado State University Experiment Station in 1976. It is of early maturity, a fairly upright growth habit and has tillers (secondary heads) that are taller and more upright which will aid in harvest. According to two-year test data from a number of Colorado locations, it will yield about 5 percent more than Common White.
8. Minco is a Common White type selected by Dr. R. G. Robison of the University of Minnesota. Named by combining Minnesota and Colorado, it was released in 1976. It tends to be several days later than Abarr and slightly taller. Seed color is a good white. It has yielded well in Colorado and should be available in the registered seed class in 1977.

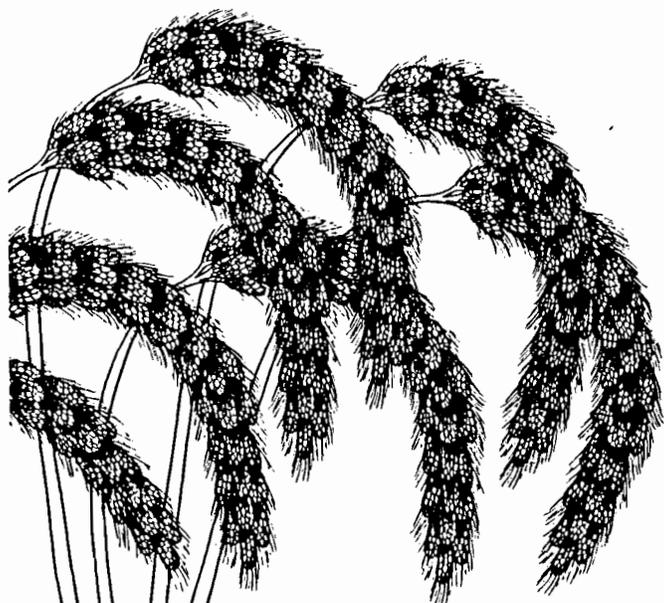
VARIETIES OF FOXTAIL MILLET

(see appendix tables for agronomic data).

1. German millet (Strain R) is a fine-stemmed, leafy strain with compact, distinctly lobed heads. It matures too late to produce seed in northeastern Colorado.
2. White Wonder is a dual purpose millet that can be used either for hay or grain. Seed color is white to light yellow. This tall plant (up to 50 inches) has a coarse stalk and stands well. The head is long and distinctly lobed. It does well on the lighter soils of northeastern Colorado and in the area of central to southeastern Colorado with a slightly longer growing season.
3. Golden German is a selection from material maintained by a grower at Wray, Colorado. The origin of this line is obscure. David Deschamps and his father, J. J. Deschamps, have maintained this line for more than 35 years. Its adaptability is well known in northeastern Colorado. The stem is not as coarse as that of White Wonder, nor is the plant as tall (up to 42 inches). Mature plants have much purple pigment in the leaf sheaths and leaves. Heads may reach 6 inches in length and are slightly lobed. Bristles, which exceed the spikelet in length and thus are termed long (15), are a definite golden brown in the mature plant. The rounded seeds are deep yellow and almost gold. The plant was released as a named variety in 1968 by the Colorado State University Experiment Station.
4. Manta is a selection of the Siberian type made by South Dakota. It is the earliest of the foxtail varieties listed here. Plants grow to 36 inches and are capable of producing a good grain crop. Seed color is orange. Plants of Manta are not as leafy as Golden German but may be a useful variety in northeastern Colorado where a short-seasoned variety is desired.
5. Butte is a bulk selection made by the Colorado State University Experiment Station from seed material (P.I. 315088) furnished by the Plant Introduction Service of the USDA-ARS. It was introduced from the USSR where



it was identified as the variety Harkovakaja. Butte has special virtue for the birdseed trade as birds have shown a preference for this variety. It is slightly earlier in maturity than Golden German as well as slightly shorter. Heads are long, tapering, relatively small in diameter and moderately lobed. Bristles or awns are short. Plants become tinged with purple at maturity.



LITERATURE CITED

1. Anderson, Elna and John H. Martin. 1949. "World production and consumption of millet and sorghum." *Econ. Bot.* 3:265-288.
2. Brandon, J. F., Alvin Kezer, J. J. Curtis, and D. W. Robertson. 1932. *Proso or hog millet in Colorado*. Bul. 383, Colo. Ag. College.
3. *Colorado Agricultural Statistics, 1972, 1973, 1974, 1975, & 1976*. Compiled by Colorado Crop and Livestock Rpt. Serv.
4. Denham, A. H. 1971. Personal communication.
5. ——— and K. Takeda. 1969. *Millet hay for wintering weaner calves*. CSU Exp. Sta. Prog. Rpt. 69-57.
6. Grabouski, P. H. *Growing proso millet in Nebraska*. SC 110, Univ. of Neb.
7. ——— and Murray Danielson. 1970. "Birdseed, also good hog feed." *Quarterly*, Vol. XVII, No. 3, Univ. of Neb.
8. Greb, B. W. 1976. Personal communication.
9. Heeney, Marvin W. 1970. *Proso or hog millet as a feed for swine*. CSU Exp. Sta. Gen. Series 894. Colo. A.E.S.
10. Jellum, M. D. and J. B. Powell. 1971. "Fatty acid composition of oil from pearl millet seed." *Agron. J.* 63:29-33.
11. Jennott, Dan R. 1974. "Yield and quality of dryland forages." Master's Thesis. Colo. State Univ., Fort Collins, Colo. 58 p.
12. Leonard, Warren H. and John H. Martin. 1963. *Cereal Crops*. Macmillan.
13. Malm, Norman R. and Laren R. Robison. 1969. "Influence of planting rates and dates on proso millet production." *Quarterly*, Vol. XV, No. 1, Univ. of Neb.
14. Martin, John H. 1937. *Proso, or hog millet*. Farmers' Bul. 1162, USDA.
15. ——— and Warren H. Leonard. 1949. *Principles of Field Crops*. Macmillan.
16. Mickelson, R. H. 1968, 1969, 1970. Annual reports for the Central Great Plains Field Station, Soil & Water Cons. Div., ARS-USDA.
17. Porter, R. H. *Wheat streak in Colorado*. Vol. 6, Colo. Farm and Home Research.
18. Vinall, H. N. 1924. *Foxtail millet: its culture and utilization in the United States*. Farmers' Bul. 793, USDA.
19. Williams, Thomas A. 1899. *Millet*. Farmers' Bul. 101, USDA.

APPENDIX

Appendix Table 1. Summary yield comparison of hay-type sorghums (sudans) and pearl millets at Walsh, Colo.¹

Variety	Tons DM from 4 cuttings	
	1973	1975
Mean of 3 sorghums ²	6.47	4.76
Pearl millet ³	5.90	4.56

¹Extracted and summarized from CSU Progress Reports 73-19 and 75-8 by Mann, H. O., E. J. Langin, and V. E. Youngman, both entitled "Yield and quality — sudan, sorgo-sudan, sorghum-sudan and pearl millet hybrids.

²In 1973, Sudax 11, Grazer N, and Trudan 4.
In 1975, Trudan 5, Sordan 70, and Haygrazer.

³In 1973, Millex 22, in 1975, Millex 23.

Appendix Table 2. Summary data of certain proso millet lines grown at Springfield, Colo.¹

Variety	Seed color	Yield in bu./acre			Mean yield	% of Common White for years of growth	Mean test wt.
		1974	1975	1976			
Minco	white	18.2	13.3	20.3	17.3	153	53.8
Abarr	white	14.1	9.3	21.2	14.9	132	52.7
Turghai	red	10.9	14.5	22.0	15.8	140	53.7
CW-21*	white	—	28.7	28.9	28.8	239	54.6
CW-21-1*	white	18.2	23.1	28.9	23.4	207	52.1
CW-21-2*	white	18.8	20.7	30.5	23.3	206	52.9
CW-21-3*	white	19.2	24.6	28.5	24.1	213	53.2
Leonard	yellow	15.4	28.0	30.0	24.5	217	55.7
CW-73-53*	white	17.4	21.5	27.5	22.1	196	54.9
CW-73-62*	white	15.8	15.7	28.6	20.0	177	54.0
Minn. 402*	white	11.4	10.4	19.4	13.7	121	54.2
Common White	white	9.8	9.2	14.9	11.3	—	52.9

*Experimental line

¹Planted on summer-fallowed land, generally in late May or early June.

Appendix Table 3. Summary grain yields of selected proso varieties grown at Akron, Colorado, for the years and planting dates indicated. All tests were grown on summer-fallowed land.

Variety	Year and date planted (Yield in bu/acre)										% Common White for years grown	
	1970		1971		1973		1974		1975			Mean
	17 June	3 June	15 June	29 June	15 June	11 June	19 June	11 June	26 June			
Turghai	12.5	37.5	37.5	24.5	33.4	38.2	33.9	41.0	29.2	32.0	98	
Common White	6.9	37.9	34.4	20.4	38.7	49.7	35.3	33.0	36.7	32.6	—	
Leonard	18.5	47.9	35.2	25.4	31.0	51.4	28.5	47.4	25.3	34.5	106	
Akron	14.3	29.5	26.1	12.4	25.7					21.6	78	
Panhandle		38.5	35.4	23.9	38.7					34.1	104	
Minco						71.3	45.0	43.7	37.5	49.4	128	
Abarr						52.6	36.9	33.9	32.7	39.0	101	
Cerise								39.0	32.8	35.9	103	
Year or date mean	13.1	38.3	33.7	21.3	33.5	52.6	35.9	39.7	32.4			

Appendix Table 4. Summary data of selected foxtail millet lines grown at Akron in 1974.¹

Variety	Whole plant				Grain		Forage
	Yield/A (Tons DM)	Protein (%)	ADF ² (%)	Protein (Lbs/A)	Yield/A (Bu.)	Test wt. (Lbs/Bu)	Yield/A (Tons DM)
Golden German	3.32	10.5	34.6	695	21.6	43.3	2.78
White Wonder	2.93	11.7	33.9	685	12.6	40.0	2.61
Manta	1.97	9.9	34.8	390	33.9	52.9	1.12
Butte	2.46	9.7	35.6	475	19.9	35.4	1.96

¹Planted June 11 on summer-fallowed land, harvested mid-Sept. immediately after killing frost.

²Acid detergent fiber.