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Plant Materials

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Comparison of Five Millet Species for Conservation Use in the United States

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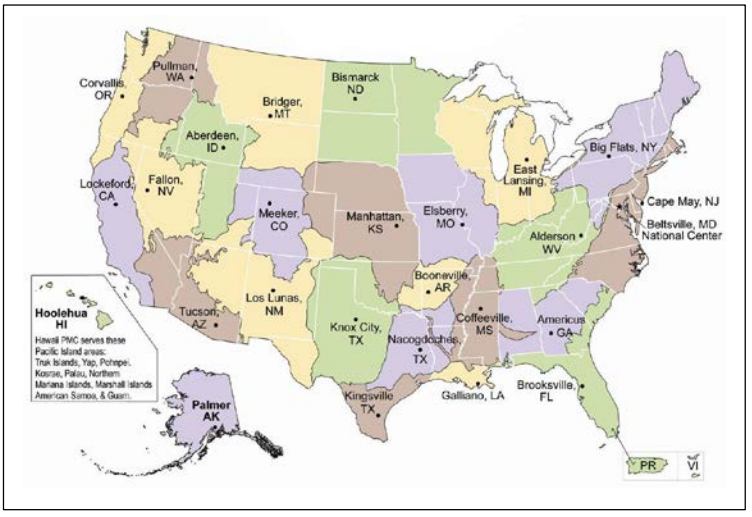
Preface

The U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Plant Materials Program has been involved in the collection, evaluation, selection, increase, and release of conservation plants for more than 75 years. This publication was prepared to provide information needed by conservationists, producers, or consultants to help make decisions regarding the use of millets for use in conservation practices, especially those focused on making use of marginal cropland, nutrient poor and water-stressed soils, periodically flooded soils, and areas needing cover crops or wildlife restoration. With future weather and climate conditions becoming more variable, less predictable, and more extreme, it is useful for growers to have a wide variety of agronomic options that include the use of millets. Due to their long history of cultivation across the world and their wide adaptability to a variety of environmental conditions, millets as a group seem uniquely positioned to be one of the more resilient crops available to farmers.

For additional information on specific species of plants mentioned in this publication, please see the USDA PLANTS database at: (http://plants.usda.gov/java/) or contact the nearest Plant Materials Center or plant materials specialist (http://plant-materials.nrcs.usda.gov/contact/) and/or the Land Grant Universities that serves the State. For specific information on soils and soil health, please see USDA NRCS soils website at: (http://www.nrcs.usda.gov/wps/portal/nrcs/site/soils/home/). Also, see technical resources on the National Plant Materials Program Web site at: (http://www.plant-materials.nrcs.usda.gov/).

Location and service areas of Plant Materials centers



Service area of the Plant Materials Program Northeast Region

Acknowledgements

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Introduction

This technical note is designed to help conservation planners identify and understand the similarities and differences between millets for use in a variety of FOTG conservation practices. Millet is a general term used to describe a variety of small-seeded cereals that are not taxonomically related, but that share similar functional roles. The millets in this technical note are all introduced, warm season, annual grasses that represent the most commonly used millets in the United States. These species are: Japanese millet (*Echinochloa esculenta*); pearl millet (*Pennisetum glaucum*); foxtail millet (*Setaria italica*); browntop millet (*Urochloa ramosa*); and proso millet (*Panicum miliaceum*). Millets have been used for food production, conservation cover, birdseed, wildlife planting, cover crops, and in critical area restoration. This technical note will mainly focus on using millet in conservation applications, especially for potential use as a cover crop.

This current Tech Note includes:

- Short descriptions of the 5 most commonly used millets in the United States
- Tables describing:
    1) areas of adaptation and major regions of production;
    2) establishment requirements and growth characteristics;
    3) positive and negative tradeoffs in application

As a group, millets represent some of the oldest cultivated crops in existence. They are most commonly used as a food source in China, Southeast Asia, India, Africa, Russia, and parts of Europe. In America, millet is mainly grown as a forage, hay, livestock/poultry feed, cover crop, birdseed, and for waterfowl habitat. Despite their differences in form, habitat, adaptation, and use, the millets listed in this Tech Note share many common characteristics:

1) They are introduced, annual, warm-season grasses
2) They are fast growing, produce abundant seed, and can become weedy
3) Can be grown as a short-season emergency crop, hay, or weed-suppressing cover crop
4) Can produce large yields with minimal additional inputs
5) Are often very drought resistant
6) Are more resilient in nutrient poor soils and heat-stressed conditions when compared to other cereals
7) Tend to be very sensitive to cold temperature and should be planted when soils reach 65° F.

Japanese Millet (*Echinochloa esculenta*)

Japanese millet is sometimes confused with barnyard grass (*E. crus-galli*), but has a compact inflorescence with reddish-purple seed with no awns, while barnyard grass has an open-branched panicle and white seeds with conspicuous awns. It can grow 2–4 ft (60–122 cm) tall. It can be grown throughout the United States from Canada to northern Mexico in both wetland and non-wetland sites. It can be found along rivers and ponds, is abundant in freshwater marshes, and can be weedy in rice fields. It is better suited for colder climates and wetter soils than other annual summer grasses such as sorghum (*Sorghum bicolor*), browntop millet (*Urochloa ramosa*), and corn (*Zea mays*) however it has limited frost tolerance and will winter kill. Similar to proso and foxtail millet, it can be planted in early summer. It is a versatile plant that can be grown in a range of soil types, in both low and medium altitudes. Japanese millet is often grown in the United States as a forage and as feed for waterfowl. It is a good food source for ducks, doves, turkeys, and pheasant. It can be planted around the edge of ponds and impoundments to provide good hunting habitat in shallow-water areas. It can produce up to 3,500 lb/ac of dried aboveground biomass and 2,000 lb/ac seed. As a cover crop it grows quickly, smothers weeds, and is a good N-scavenger.

For more information regarding Japanese millet please consult the USDA NRCS Plants Database: http://plants.usda.gov/core/profile?symbol=ECES

Pearl Millet
(*Pennisetum glaucum*)

Similar to Japanese millet, pearl millet can be grown throughout the United States, however it is not suitable for use in flooded fields or wet soils. It originated from the Sahel region in Africa and is a drought resistant upland plant that grows best in dry sites. It has woodier stems than sorghum and can grow 4–8 feet tall. The inflorescence (4–20 in) is a terminal spike, resembling that of cattail. Pearl millet is the preferred-choice for forage when compared to other millets like browntop, Japanese, and proso millet, and it is also frequently used as poultry feed. Due to pearl millet's large stems, hay production is difficult without a hay or mower conditioner, and extra time will be needed for drying. It can also be used as a fast-growing cover crop that can increase organic matter, scavenge residual nutrients, create large amounts of surface mulch, reduce compaction, and reduce root-lesion nematodes with few additional inputs. It has a dense, fibrous root system that produces large amounts of root dry matter. It can be included in mixes with forage legumes such as cowpea, lab lab, or soy bean. Pearl millet is the food source for quail, turkey, doves, and ducks and can be used in waterfowl planting and for birdseed mixes. There are several pearl millet varieties on the market, with some able to produce 9,000 lb/ac of dry matter, and 3,500 lb/ac of seed.

For more information regarding pearl millet please consult the USDA NRCS Plants Database:
http://plants.usda.gov/core/profile?symbol=PEGL2

Foxtail Millet
(*Setaria italica*)

Foxtail millet is considered one of the oldest cultivated millets. It is grown in cooler, droughtier regions than other millets. In the United States, foxtail millet is mainly grown in the northern and western Great Plains, Midwest, the Dakotas, Colorado, Kansas, Nebraska, and Wyoming. It can grow in semi-arid conditions, and does not grow well in wetlands or saturated soils. It can grow in a range of soil types, from sandy to loamy soils, and can tolerate high salinity. Stems of foxtail millet are more slender than pearl millet and it can grow 2–5 feet tall. It has a nodding inflorescence with dense and bristly seedheads. Foxtail millet is primarily grown for hay and is similar to other warm-season grasses in terms of forage quality. It can also be used in place of corn in broiler chicken diets. Foxtail millet does not produce as much biomass as pearl millet, but can produce 1–3.5 tons/ac of aboveground biomass and 2,000 lb/ac of seed. The seed is often grown for use in birdseed mixes, and in food plots for turkey, quail, and dove. Like Japanese millet, foxtail millet can be used as a fast-growing, weed suppressing cover crop. Its residue is more persistent than other residue like soybean and buckwheat, and may be too thick for no-till planting. Like proso and browntop millet, there is little regrowth after cutting.

For more information regarding foxtail millet please consult the USDA NRCS Plants Database:
http://plants.usda.gov/core/profile?symbol=SEIT

Browntop Millet (*Urochloa ramosa*)

Browntop millet is adaptable to almost all upland soil, and normally occurs in non-wetlands. It is most often grown in the same South/Southeast region as pearl millet, while proso millet, foxtail millet, and Japanese millet are most often grown in the North, Midwest, and Central Plains. The stem may be erect or prostrate along the ground, and grow to 3 feet tall. There may be 3–15 indeterminate, open, spreading inflorescences with a simple axis and stalked flowers. The fibrous roots can grow 2 feet deep. It is grown for hay, pasture, and game bird feed. Compared to other warm season forage grasses, browntop millet is relatively low yielding. Browntop millet can yield 1,800–4,000 lb/ac dry matter and 1,500 lb of seed/ac. Like the other millets mentioned in this document, browntop millet can be used as a fast-growing, weed-suppressing catch crop between commodity crops. It can also suppress root-knot nematodes. Browntop millet is a prolific seed producer that is often planted to attract wild game like pheasants, turkeys, and ducks. The seed is also widely eaten by mourning doves and is used in commercial birdseed mixes. Browntop millet is also an important plant for remediation of soils contaminated with lead and zinc.

For more information regarding browntop millet please consult the USDA NRCS Plants Database:
http://plants.usda.gov/core/profile?symbol=URRA

Proso Millet (*Panicum miliaceum*)

Proso millet is mainly grown in the United States in the Great Plains states of Nebraska, South Dakota, and Colorado, with less production in Kansas, Wyoming, and Minnesota. Like several other millets in this document, proso millet is widely adapted to many soil types, is heat and drought-tolerant, and grows best in dryer upland sites. It is especially notable for its efficient water use in water-limited environments. It can grow 1–3½ ft tall and has a drooping, branched, compact inflorescence 4–18 in (10–45 cm) long made of many stalked, ovoid spikelets. It is grown for grazing, and game bird feed. Proso millet is also used in the place of sorghum or corn in cattle and swine food rations. It can produce 2,000 lb/ac of seed, and 2,000–3,000 lb/ac of biomass. Proso millet can be planted as a catch crop into corn and sorghum stubble fields, or included in a cover crop mix with cowpeas or soybeans. Proso millet seed is eaten by bobwhite quail, mourning doves, pheasants, turkeys, and a variety of songbirds. It is also used in mixes for herbaceous conservation buffers/filter strips in USDA Wildlife Habitat Incentives Program (WHIP) applications.

For more information regarding proso millet please consult the USDA NRCS Plants Database:
http://plants.usda.gov/core/profile?symbol=PAMI2

Table 1. List of millets describing use, adaptation, and region of use.

Plant Species	Other Names	Principle Use	Habitat	Soils	Adaptation	pH	Region Planted in US
Japanese Millet (*Echinochloa esculenta*)	barnyard millet; billion dollar grass	forage; waterfowl feed; cover crop	wetlands/non-wetlands	does not grow well on sandy soils-tolerates poorly drained soils	colder climates	4.5–7.4	Northeast
Pearl Millet (*Pennisetum glaucum*)	bulrush millet	grazing, cover crop; wildlife	non-wetlands/uplands; wetlands (occasional)	grows well in sandy and acid soils with low fertility	colder and warmer climates	5.5–7	South/Southeast, Southeastern Coastal Plain, throughout US
Foxtail Millet (*Setaria italica*)	Italian millet; German millet	hay; cover crop; birdseed	non-wetlands/uplands	**s**andy to loamy soils	colder climates and warmer climates; semi-arid conditions	5.5–7	Central Plains/ Midwest
Browntop Millet (*Urochloa ramosa*)	Dixie signalgrass	forage; cover crop; wildlife	non-wetlands/ uplands	best on sandy loam	warmer climates	5–6.5	South/Southeast
Proso Millet (*Panicum miliaceum*)	broomcorn millet	forage; commercial birdseed	moist or dry conditions	adapted to poor soils; many soil types	colder climates and warmer climates/tropics & subtropics	5.5–7.8	Central Plains/ Midwest

Table 2. List of establishment requirements, management, and production of commonly used millets.

Plant Species	Planting Date	Seeding Rate	Management	Pests/Potential Problems	Time of mature seed set	Seeds/Plant Production	Weediness
Japanese Millet (*Echinochloa esculenta*)	Summer (Jun.-Aug.)	15–25 lb/ac drilled; 30 lb/ac broadcast	Moist soil is required for optimum germination	may be a host for root knot nematodes	60–90 days	1,500–2,000 lb/ac seed; 143,000 seeds/lb	May become weedy
Pearl Millet (*Pennisetum glaucum*)	similar to sorghum; summer (soil temp. at least 65°F)	12–15 lb/ac drilled; 30–40 lb/ac broadcast	It will regrow after cutting to 6–8 inches	fall armyworm, leafspot, rust disease	60–70 days	3,500 lb/ac seedp; 60,000–90,000 seeds/lb	Low threat of spread
Foxtail Millet (*Setaria italica*)	late spring, early summer (soil temp. at least 65°F)	15–20 lb/ac drilled; 20–30 lb/ac broadcast	Rolling with crimper may leave too much residue on surface	hosts mite responsible for wheat streak mosaic, leaf spot,	70–90 days	2,000 lb/ac seed; 230,000 seeds/lb	May become weedy
Browntop Millet (*Urochloa ramosa*)	late spring, early summer	15–20 lb/ac drilled; 25–30 lb/ac broadcast	Seedling growth suppressed by previous crop residues	armyworms; grasshoppers; mung bean yellow mosaic virus	60 days	1,500 lb/ac seed; 140,000 seeds/lb	May become weedy
Proso Millet (*Panicum miliaceum*)	late spring, early summer	30–40 lb/ac drilled;	Does not benefit from high-input of nutrients or water	few insect problems; thrips, grasshoppers, European corn borer	60–90 days	2,000 lb/ac seed	May become weedy

Table 3. List of positive and negative characteristics of various species of millet.

Species	Positive Characteristics	Negative Characteristics
Japanese Millet (*Echinochloa esculenta*)	• can grow in flooded soils and standing water • can be used as a weed-suppressing cover crop • can tolerate slightly saline water (2,000–3,000 ppm) • good N-scavenger • can tolerate frequent cutting	• not recommended for aerial seeding • may be too aggressive for seeding mixes • may become weedy • will not survive fire • can grow poorly on sandy soils
Pearl Millet (*Pennisetum glaucum*)	• preferred millet for forage • deep roots can scavenge nutrients • one of the most drought resistant grains • safe to feed horses • well suited to break up compacted soils • performs well on sandy soils	• can accumulate high levels of nitrate • grain harvest can be limited due to rust disease • requires a conditioner for hay production
Foxtail Millet (*Setaria italica*)	• fast-growing with relatively high yields • can be used as a weed-suppressing cover crop • high water-use efficiency; able to grow in semi-arid environments • high salinity tolerance	• can only be cut once • may accumulate nitrate • lacks some essential vitamins and nutrients as feed • residue may be too thick for no-till
Browntop Millet (*Urochloa ramosa*)	• fast-growing catch crop • large seed producer for wildlife • can accumulate lead and zinc • suppresses root-knot nematodes	• needs air temp. > 52°F • relatively low yield • can accumulate nitrate • can become weedy
Proso Millet (*Panicum miliaceum*)	• fast-growing catch crop • very low water requirement • can be used as substitute for sorghum or corn in cattle diet	• poor tolerance to high salinity • little regrowth after cutting • seed shatters easily and plant tends to lodge