



Rye

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Although usually harvested for use in food and beverage products and for livestock feed, rye (*Secale cereale*, also known as cereal rye, winter rye, or grain rye) possesses several features that make it an excellent green manure. It grows rapidly, produces an extensive, fibrous root system, and is valued for controlling erosion on sloping fields, improving soil tilth, and adding organic matter. Rye's ability to smother and suppress weeds makes it a favorite for reducing herbicide use on the farm. It can contribute to a farm's sustainability with the options of grazing or harvesting it for straw or feed.

Characteristics

Rye grain is a cool-season annual cereal grain that grows 3–6 ft tall. It has flat, blue-green leaf blades and flower spikes. The spikes have two or more spikelets bearing florets that develop into one-seeded fruits—the rye grains. In Hawaii, a rye crop establishes in about 90 days. The root system of cereal rye is more extensive than that of other cereal crops.

Environmental requirements

Rye grows best on well drained loam or clay loam soils, but it can grow on heavy clays, light sands, and infertile or poorly drained soils. It tolerates a pH range from 4.5 to 8.0 but performs best at pH 5.0–7.0. Rye is widely adapted to different climates but grows best in cool zones and at higher elevations. In Hawaii, plant rye year-round at elevations above 1500 ft. At lower elevations, its optimum planting period is during the cooler fall and winter seasons. Rye is among the most drought tolerant cereal crops, and it also grows better under drought conditions than legume cover crops. Rye normally outperforms other cereals under drought conditions and on sandy, infertile soils.

Benefits provided by rye

EXCELLENT for quick growth and establishment, suppressing weeds, increasing soil organic matter and improving soil structure, taking up and storing soil N and preventing its loss to leaching, providing lasting residue, and controlling erosion

TOLERATES infertile, sandy soils, drought, and shade; many cultivars tolerate waterlogging

GOOD for use as a low windbreak

SUITABLE for higher elevations

POOR quality of grain and straw as livestock feed

USE IN annual production systems including vegetables, herbs, cut flowers and ornamentals, and dryland taro



Cultivars

The rye grain cultivar commonly recommended by the USDA Natural Resources Conservation Service in Hawaii is 'Wrens Abruzzi.' CTAHR cover crop variety trials on the islands of Hawaii, Molokai, and Lanai suggest that 'Danko' and 'Elbon' are most promising in terms of vigorous growth, rapid soil cover, weed suppression, low plant height, and lack of flowering.

'Merced', a "Spring" type that is reportedly tolerant of drought, grew adequately at CTAHR's low elevation Waimanalo Research Station on Oahu.

Establishment

Broadcast pure live seed at 90–160 lb/acre (1.5–3.0 bu/acre) or drill at 60–120 lb/acre (1–2 bu/acre). A mixture of rye and hairy vetch is popular in some areas, as the rye plant provides good structural support for the companion legume. Planting rates for these crop mixtures used in other states are about 70–80 lb of rye and 20–25 lb of hairy vetch seed per acre. Broadcast and cover or drill to a depth of $\frac{3}{4}$ –2 inches.

Uses

Weed control

Rye is useful for reduced-chemical weed control in several ways. It is excellent at outcompeting weeds, especially small seeded, light-sensitive annuals. Rye also can suppress weeds with allelopathic compounds, which are plant-made, herbicide-like chemicals that inhibit weed germination. Rye seedlings have more of these compounds than the mature rye residues. Allelopathic effects usually last about 30 days. Be aware that some cash crops, such as carrots and onions, are also sensitive to these compounds.

Several demonstration trials with rye as a cover crop were conducted at CTAHR's low-elevation Waimanalo Research Station on Oahu. The stands were somewhat sparse and the growth was not as vigorous as it might have been under cooler, upland growing conditions. However, this may be an advantage if one is looking for a grass intercrop that is not overly aggressive. Despite its somewhat slower growth, rye provided effective levels of weed control. In a no-till experiment, the level of weed pressure (percent of area covered by weeds) in rye plots a month after planting was 35%, compared to 42% for oats.

Because of its relatively slower, weaker growth at low elevations, mixtures of rye with a legume cover crop may be more effective for weed suppression than rye alone. This assumption was also tested at Waimanalo. The levels of weed cover observed 4 months after cover crop planting were 7.2% for rye alone, 6% for a mixture of rye and common vetch, 3.5% for rye plus hairy vetch, 1% for barley plus buckwheat, and 3.5% for 14-month-old sorghum-sudangrass. Thus the best level of weed

suppression when rye was used was when it was grown with hairy vetch.

Soil improvement

Rye produces about 1 ton/acre dry matter and about 18 lb of nitrogen per ton of dry matter, according to the USDA Natural Resources Conservation Service (NRCS); even greater yields are often reported. Fresh biomass yield obtained at Waimanalo was about 6000 lb/acre at 2 months after sowing a spring (May) crop, which was about half the yield reported for cool-season production. This production was about a fourth of that obtained in a concurrent planting of common oats at the same site.

The N tissue content of rye is about 1–1½% (see Table 1). For optimal decomposition of rye residues, add 20 lb N/ton dry matter at plow-down. This helps to prevent the decomposition process from tying up soil N needed by the following crop. Early plow-down before the rye is over 18 inches tall and when its tissues are still succulent can also help reduce soil N tie-up. Alternatively, planting rye mixed with a legume can minimize the problem.

The living part of soils includes a wide variety of microorganisms including bacteria, actinomycetes, fungi, protozoa, and algae. It also includes plant roots, insects, and earthworms. A diverse and rich biological community is important to maintain a healthy soil environment for plant growth. Because soil organic matter acts as the "fuel" feeding this biological community, incorporating rye residues into the soil provides energy for this diverse group of soil organisms.

Use rye to build up the fertility of sandy, infertile soils. Few other high elevation or cool season green manure crops are as productive on poor soils as rye.

Rye used as a green manure serves as a storehouse of nutrients in the soil, saving these nutrients for a following cash crop. Rye also improves water quality be-

Table 1. Tissue nutrient levels of 'Merced' rye and 'Cayuse' common oats grown at the CTAHR Waimanalo Research Station, Oahu.

Crop	N	P	K	Ca	Mg	Na	Mn	Fe	Cu	Zn	B
Oats	1.2	0.41	4.02	0.45	0.26	0.12	71	452	1	18	6
Rye	1.5	0.29	1.78	0.53	0.20	0.04	163	2704	7	36	13

cause the plant's extensive root system takes up any excess soil N that would otherwise leach to contaminate groundwater or surface water bodies. This N is taken up by the plant, and then it slowly becomes available to subsequent crops as the residues gradually decompose. Rye roots can also extract potassium and other nutrients from deep in the soil profile and bring them to the surface, where they become available to subsequent crops. Expect considerable fertility improvement in the topsoil when growing rye as a catch crop.

Erosion control on slopes

Rye has been used for many years for soil conservation on sloping fields. Its vigorous and fibrous root system effectively holds soil in place while it improves water infiltration, conserves moisture, and improves soil tilth.

Nematode control

Cereal rye is not a host plant for root-knot nematodes or soil-borne diseases, and it can be used in rotations to help control plant pathogens.

Habitat for beneficial insects

Rye produces biomass that provides habitat (but not a food source) for beneficial insects that are predators of insect pests. Modest numbers of beneficials can be found in rye plantings.

Windbreak

Rye can also be used effectively as a windbreak, especially at high elevations. For wind-sensitive crops such as onions and leafy vegetable crops, it may be advisable to plant rye strips as windbreaks between the crop rows or beds. Once the crop is well established, you can mow the rye and leave the residues in the field as a weed-smothering, moisture-conserving mulch. The windbreak and its residues may also serve as a refuge for beneficial organisms.

Management cautions

Allelopathic compounds in rye may affect germination of the subsequent crop in the rotation. Wait 30 days before replanting, or choose crops that are not affected. Rye can become a weed if allowed to set seed.

Pest problems

Rye harbors few diseases when used as a cover crop. When growing rye for grain, rotate crops, plow down residues, and select resistant varieties to minimize occurrence of rust, stem smut, and anthracnose.

For assistance:

Contact your nearest Cooperative Extension Service office for additional assistance in selecting appropriate cover crops and green manures for your farm and cropping situation. Help can also be obtained from the USDA Natural Resources Conservation Service field offices located on each island.

Visit CTAHR's Sustainable Agriculture for Hawaii Program Website at <<http://www.ctahr.hawaii.edu/sustainag>> to find additional information about green manure and cover crops. The site also includes references and links to other useful on-line resources.



Sustainable Agriculture in Hawaii . . .

. . . integrates three main goals—environmental health, economic profitability, and social and economic equity. Sustainable farms differ from conventional ones in that they rely more on management practices such as crop diversification and crop rotation, agroforestry, integrated pest management, rotational grazing, and innovative marketing strategies. For further information on Sustainable Agriculture in Hawaii, contact:

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