

ALFALFA NUTRIENT REQUIREMENTS, DEFICIENCY SYMPTOMS, AND FERTILIZER APPLICATION

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There are 18 nutrients essential or beneficial for the growth of alfalfa which can be classified roughly according to their concentration in the plant: 1) Structural nutrients – carbon, hydrogen, and oxygen 2) Macronutrients – nitrogen, phosphorus, and potassium, 3) Secondary nutrients – calcium, magnesium, and sulfur, 4) Micronutrients – iron, manganese, boron, zinc, copper, molybdenum, chlorine, nickel, and cobalt.

The structural nutrients (carbon, hydrogen, and oxygen) are not provided by the soil like most other nutrients but rather, by the air and water. The structural nutrients account for about 91-92% of the dry weight of the alfalfa plant. These nutrients form carbohydrate chains that comprise the fiber and cell wall portions of the plant.

The macronutrients are most often deficient in plants. Most plants obtain their nitrogen from the soil, but alfalfa is in a class of plants called legumes that can obtain nitrogen from the air via rhizobia bacteria that form nodules on the roots. Alfalfa can and will take up nitrogen directly from the soil like other plants, and approximately a quarter to half of the nitrogen taken up by alfalfa may be from the soil. Application of nitrogen fertilizer is generally not recommended for alfalfa since it inhibits the fixation of nitrogen from the air and weed growth is encouraged. However, some nitrogen fertilizer may be beneficial at planting time before the nodules become established on the roots. Land that has not had an alfalfa crop would benefit from coating of the seed with rhizobia bacteria or mixing bacteria in the seed box. Alfalfa generally does not respond to nitrogen fertilizer but may do so under any of the following conditions: seedling alfalfa, spring cuttings, high yield levels, alfalfa-grass mixtures, molybdenum deficiency (this affects nitrogen fixation by bacteria), or problem soils (hot, cold, waterlogged, shallow, compacted, sandy, low pH).

Phosphorus is the nutrient most often required by alfalfa in arid and semi-arid areas even though the crop uptake for other nutrients such as nitrogen, potassium, and calcium is much greater. Phosphorus is needed as a fertilizer for alfalfa more often than other nutrients since this nutrient is tied up in soils typical of California and other regions. In high pH soils, phosphorus forms a mineral with calcium called apatite which is about as soluble as concrete. Phosphorus is transported to the roots by the process of diffusion, which slows down greatly when the soil is cold. Therefore, phosphorus is needed especially during the cooler months of the year.

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Phosphorus fertilizer can be applied as a granule at planting time or topdressed, or applied as a liquid in the irrigation water. Liquid and granular forms of phosphorus fertilizer have been found to be similar in effectiveness in increasing yield and similar in movement in the soil.

Alfalfa takes up a large amount of potassium, but fertilization with potassium fertilizer is less frequently required than phosphorus because potassium content of the soil is usually adequate. Potassium deficiencies may be observed on sandy soils or following other crops that take up large amounts of potassium such as tomatoes.

Deficiencies of secondary nutrients are not common in alfalfa but can occur in certain instances. Calcium deficiency is not expected in California. Magnesium and sulfur deficiency may occur in sandy soils or soils with low organic matter.

Micronutrient deficiencies are not expected in arid and semi-arid areas except for boron and molybdenum. Boron deficiencies are possible but seldom observed. Molybdenum deficiency is a bit more common, but this nutrient is generally not needed in the San Joaquin Valley but may be deficient in other areas. Molybdenum deficiency in alfalfa affects the function of the nitrogen fixing bacteria, so the plants turn yellow and respond to nitrogen fertilizer. Cobalt is not essential for alfalfa growth, but is required by rhizobia bacteria that provides alfalfa with nitrogen from the air, and therefore is beneficial to the alfalfa plant.

Alfalfa often exhibits symptoms that may mimic nutrient deficiencies such as purpling or yellowing of the leaves. Various insects and diseases or weather conditions can cause these symptoms and should not be confused with nutrient deficiencies. For example, the three cornered alfalfa hopper can girdle the stem and cause the leaves to turn purple, similar to phosphorus deficiency. Alfalfa mosaic virus can cause leaf yellowing that may be confused with a micronutrient deficiency. Cold weather can also cause some purpling or yellowing.

Nutrient deficiencies can be diagnosed using visual symptoms, soil testing, or plant tissue analysis. Plant tissue analysis can be misused. Low concentration of a nutrient in a plant may be caused by other factors such as loss of root effectiveness due to nematodes or leaf loss due to foliar disease or water stress. Even if a nutrient deficiency exists, it may not be possible to correct with application of the nutrient in question if the deficiency is caused by other factors such as pH or waterlogging.

Fertilizer products are on the market that have not been adequately tested and may not produce desired results. There are 18 nutrients that are known to be essential or beneficial for the growth of alfalfa, but there are about 100 chemical elements in the earth's crust. These other elements are not expected to have an effect on alfalfa. There are also many products on the market that claim to be biological soil enhancers that have a combination of an extract of some sort and micro-organisms. Adding a small amount of bacteria or other active ingredient to the soil is not expected to have any effect on soil properties or nutrient uptake.

Table 1. Nutrient deficiency symptoms and fertilizer rates for alfalfa in California and other arid and semi-arid regions.

Nutrient	Deficiency symptoms	Conditions favoring deficiency	Fertilizer form	Maximum Nutrient rate
Nitrogen	General yellowing especially of older leaves, a pinkish color may develop in the petiole or midrib	Poor nodulation	UAN32, urea	50 lbs N/a per cutting
Phosphorus	Leaves small and dark-green, underside purplish, leaflets may fold	Cold soils, seedling alfalfa	11-52-0 10-34-0	100 lbs P ₂ O ₅ /a per year
Potassium	Small white spots on the outer edges of upper leaflets	Sandy soils	Potassium chloride or sulfate	300 lbs K ₂ O/a
Magnesium	Yellowing between veins on older leaves, leaf margins turn yellow, redden, and die.	High soil potassium or sodium, sandy soils, soils with low organic matter	Dolomitic limestone, Epsom salt	Variable
Sulfur	Yellowing of new leaves, growth stunted, leaves become long and slender	Sandy soils, soils with low organic matter	Sulfur, gypsum	15 to 50 lbs S/a per year
Boron	Plant tops become yellow and reddish	Soil pH of 8.5, low organic matter soils	Borax, borosilicate, boric acid	1 to 3 lbs B/a
Molybdenum	General yellowing of older leaves followed by bleaching	Low pH, high iron	Ammonium or sodium molydate	0.1 to 0.5 lbs Mo/a