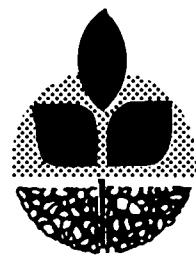


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"Sick" Alfalfa



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ABSTRACT

One cause of "sick" alfalfa in eastern Oregon appears to be a nitrogen deficiency associated with poor or ineffective nodulation. Affected fields were yellowish-green and responded dramatically to nitrogen fertilization. Nitrogen content of affected plants was very low and the N:S ratio was well below the critical value of 11. The levels of other nutrients in the plants were adequate; therefore, nitrogen deficiency was probably the cause of the poor production. Normal productive stands have been obtained experimentally on fields previously growing "sick" alfalfa by planting freshly inoculated seed and following other recommended practices of seedbed preparation, fertilization and weed control. These results suggest that good management can overcome at least some of the "sick" alfalfa problems.

"SICK" ALFALFA

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For lack of a better term, certain unproductive alfalfa fields have been called "sick". These fields are reported by growers to have produced alfalfa satisfactorily at one time. Several characteristics found in "sick" alfalfa provide a basis for separating these fields from other unproductive fields. Affected plants have a yellowish-green color typical of nitrogen deficiency. Each crown produces only a few stems and growth is spindly and short. A few plants which appear normal in color, size and productivity are randomly scattered throughout affected fields.

This condition of alfalfa has been observed for twenty years or more. During this period only a small acreage at any one time has been affected in central and northeast Oregon. "Sick" alfalfa occurs in eastern Washington (5), Idaho mainly in the northern part (2), and northward into Canada (3, 6). Symptoms reported throughout the area are similar to those in Oregon.

The problem is primarily limited to alfalfa. Normal productive plants of other legumes -- red, alsike, and white clover; garden peas; Austrian winter peas -- have been observed growing among affected alfalfa plants. Examination of roots of the other legumes when they are growing rapidly in mid-spring show good to excellent nodulation. The nodules on these legumes and the few healthy alfalfa plants appear plump and pinkish-white in color. In contrast, good nodules are absent from sick plants and only a few dull white to greenish white ineffective nodules are found.

Sick plants of winter hardy, wilt resistant varieties maintain a good stand for several years providing they are not suffering from an

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apparent nutrient deficiency or from too little or too much water. Many affected fields over a period of two to four years gradually become more productive. The number of vigorous plants increase and the number of sick plants decrease. Recovery has been sufficient in some fields that yields have increased from approximately a half ton per acre annually to three or more tons per acre. Work in Canada by Coplen and Webster (3) show that the few normal plants in young stands are not genetically resistant to whatever causes "sick" alfalfa.

"Sick" alfalfa does not seem to be confined to any particular soil type. In Baker County, "sick" alfalfa has been observed on Hutchinson and Ladd soils located on glacial outwash terraces and fans (Table 1). In Union County, affected alfalfa has occurred on a variety of soils as Catherine, Conley, Couse, Emily, Rock Creek, and Tolo (Table 1). Many of these soils are droughty because of restricting layers, coarse textured subsoils, or shallow profiles. Restricting layers, besides being a factor contributing to drought conditions during periods of little or no precipitation, aid in causing an undesirable water logged condition of the surface soil horizons during high rainfall periods in the winter and early spring. Legumes under stress from too much or too little water often will slough their nodules. However, this appears to be of no aid in explaining why "sick" alfalfa is not nodulated and other legumes are nodulated during favorable growth periods.

Table 1. Classification of soils on which sick alfalfa has been observed

Series	Subgroup	Family
Catherine	Cumulic haplaquolls	Fine-silty, mixed, noncalcareous, mesic
Conley	Aeric xeric argialbolls	Fine, montmorillonitic, mesic
Couse	Ultic haploixerolls	Fine-silty, mixed, frigid
Emily	Ultic haploixerolls	Loamy-skeletal, mixed, frigid
Hutchinson	Typic durixerolls	Fine, montmorillonitic, mesic
Ladd	Typic agrixerolls	Fine-loamy, mixed
Rock Creek	Lithic argixerolls	Loamy-skeletal, mixed, mesic
Tolo	Typic vitrandepts	Ashy over loamy, mixed, frigid

Much of the "sick" alfalfa observed has been on soils cleared of forest or on soils in close proximity to forested land. Heavy grazing by deer and elk in late winter and early spring occurs in some fields.

Affected plants grow normally until they exhaust soil nitrogen. Then, because of their failure to fix nitrogen symbiotically, these plants exhibit the chlorotic symptoms of nitrogen deficiency. When alfalfa is planted with a nurse crop, chlorotic symptoms are evident by early summer in the year of planting. Affected plants one or more years old are chlorotic by the time the spring growth is four to five inches high. This stage of growth is the best time to observe differences in nodulation between affected and unaffected plants.

Non-productive, chlorotic alfalfa, very similar to "sick" alfalfa, has been observed in fields planted to alfalfa for the first time. The seed was not inoculated and no nodules were observed on the roots. A nitrogen deficiency existed which apparently is the cause of "sick" alfalfa. The term "sick" alfalfa implies the field once grew good productive alfalfa. Apparently, in the affected fields, sufficient rhizobia of effective nitrogen fixing strains did not survive in the soil to inoculate a new seeding of alfalfa. Why effective rhizobia do not survive in these fields is not known.

Research Work

Numerous soil fertility experiments have been applied on established stands of "sick" alfalfa with the intent of trying to determine if a nutrient deficiency was the cause of the poor growth. Essentially, satisfactory growth and color of the plant have not been obtained from any fertilizer applied except nitrogen. Marked responses to nitrogen have been obtained and this strongly suggests that poor nitrogen fixation is the primary cause of the poor growth. Healthy alfalfa should have enough nitrogen for its needs through symbiotic nitrogen fixation by the nodules growing on its roots. Obtaining increased alfalfa growth from an application of nitrogen fertilizer, however, is uneconomical. Small increases in growth but no change in plant color has occurred from applications of phosphorus and sulfur alone or together. "Sick" alfalfa may occur on soils deficient in plant nutrients, mainly phosphorus and sulfur,

but this does not appear to be the primary cause of sick alfalfa. Applying fertilizer to sick plants has not increased the amount of nodules observed on the roots.

Three methods have been tried to get inoculation and establishment of nodules on affected plants. A small amount of soil from a field producing healthy nodulated alfalfa was scattered over an area producing "sick" alfalfa. Secondly, commercial inoculum was mixed with soil and the mixture was applied to affected areas. These treatments were applied during damp rainy days when spring growth was starting. The third method consisted of pouring commercial inoculum into small holes made in the soil where sick alfalfa was growing. The soil was kept moist by irrigating. None of these methods increased nodulation or plant vigor.

Greenhouse and laboratory work (1) was conducted on seven soils taken from eastern Oregon fields where "sick" alfalfa had been observed. Inoculated and non-inoculated alfalfa was grown on sterilized and unsterilized soil with and without applied nitrogen. Results indicated that biological antagonism to effective nodulation existed in at least some of the soils where "sick" alfalfa had been observed.

Paired samples of normal and affected plants were taken from a number of fields in Union County. These samples were analyzed for nitrogen, sulfur, phosphorus, potassium, calcium, magnesium, zinc, iron, manganese and copper. Except for nitrogen, affected plants were almost always higher in these essential nutrients than were the normal plants. This is almost certainly due to the dilution effect of better growth of the normal plants as compared to the sick ones. Except for nitrogen and sulfur, the levels of nutrients were within the adequate range.

Table 2. Nitrogen and sulfur contents of paired alfalfa samples taken from five fields growing both "sick" and normal plants

Field	Condition of plants	%N	%S	N:S
1	Normal	2.25	.15	15.0
	Sick	1.57	.43	3.7
2	Normal	2.39	.16	14.9
	Sick	1.44	.21	6.9
3	Normal	2.46	.24	10.3
	Sick	1.63	.28	5.8
4	Normal	2.61	.21	12.4
	Sick	1.64	.26	6.3
5	Normal	2.36	.16	14.8
	Sick	1.52	.27	5.6

Table 2 shows the results for nitrogen and sulfur. In every case, the nitrogen levels were much lower in the affected plants as compared to the normal ones. The N:S ratios of affected plants were all well below the critical ratio of 11 (4) which indicates that these plants were not sulfur deficient but were probably nitrogen deficient. This is additional evidence that "sick" alfalfa is probably the result of poor nitrogen fixation.

Productive normal stands have been obtained, however, by planting freshly inoculated seed on well prepared seedbeds in fields which had been growing "sick" alfalfa. Phosphorus was applied if a soil test indicated an inadequate level of phosphorus in the soil. Sulfur was applied at rates of 10 to 40 pounds per acre. Seedbeds were moist, firm, and free of weeds and the alfalfa was planted without a nurse crop. These results suggest that good management practices can be employed to overcome at least some of the "sick" alfalfa problems.

Suggestions for Stand Establishment

The following are suggested as aids in minimizing or eliminating "sick" alfalfa. Of these, suggestions 1 and 2 are believed to be the most important in avoiding this condition.

1. Plant on a seedbed which is moist, fertile, firm, and free of weeds, insects, and diseases.
2. Inoculate the alfalfa seed just prior to planting with fresh inoculum which has been stored under cool, darkened conditions. Carefully follow the instructions printed on the package containing the inoculum. Avoid letting freshly inoculated seed dry out or become exposed to the sun. If sick alfalfa has been observed in the area, increase the amount of inoculum applied. Inoculum is relatively cheap.
3. Use a soil test as a guide to determine if phosphorus fertilizer is needed. Phosphorus should be worked into the seedbed prior to planting or banded at planting time. Apply sulfur if previous experience indicates sulfur might be needed. Additional information on fertilization of alfalfa is contained in the OSU Fertilizer Guide for Alfalfa (FG20).
4. Plant a winter hardy, long-lived, wilt resistant variety.
5. Plant the alfalfa without a nurse crop or a companion crop.
6. Apply supplemental water to the new seeding if possible.
7. Do not graze or cut the new seeding until it has become well established. Do not graze in late fall or early spring.

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