Establishment of Subclover

inoculation with nitrogen-fixing bacteria found to be an insurance against failure of stand establishment

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Establishment of subclover—subterranean clover—requires inoculation of seed with nitrogen-fixing bacteria.

Inoculation is done by placing the bacteria directly on the legume seed just before planting. The bacteria stimulate the roots into producing the nodules in which the bacteria live. The bacteria use nutrients formed by the plant and nitrogen from the soil air to form their body tissues. The free atmospheric nitrogen thus fixed becomes available to the plant. This process of nitrogen fixation by legumes produces high-protein forage, and improves the fertility and structure of the soil as the legume roots die and decay.

Subclover is a promising legume for dryland ranges in the northcoast counties and in the Sacramento Valley foothills.

It is sometimes difficult to obtain a satisfactory stand on land which normally would be expected to produce good subclover. On a dryland pasture near Petrolia in Humboldt County, subclover was first tried in a test plot in the fall of 1948. A stand of seedlings emerged, but the plants were stunted and yellowish to brownish in color; they died before producing any forage or setting seed. Attempts to establish subclover failed until an application of unthreshed subclover straw was tried. A good stand of dark green vigorous plants resulted—a striking contrast to the failures resulting from the previous plantings.

Three characteristics of the straw were considered to be potentially important in obtaining a stand of subclover: *1.* The large amount of seed contained in the straw—lots tested had seed contents ranging from 70 to 190 pounds per 1,000 pounds of straw; *2.* The mulching effect—the straw may act as an insulator reducing the amount of frost heaving and also may favor soil moisture by reducing runoff and evaporation; and *3.* The presence of legume bacteria—the straw contained an appreciable amount of soil clinging to the burs.

These factors were tested by treatments involving a heavy rate of seeding, an inert mulch, a commercial inoculum, and a mulch-inoculation combination. A subclover-straw treatment, using 1,000 pounds per acre, was included for comparison.

Except for the subclover-straw treatment all treatments received a heavy rate of seeding of 120 pounds an acre. There were very few healthy plants where no inoculation was used. The mulch did not improve the stand.

The addition of commercial inoculum to the seed at planting improved the stand more than six times. The addition of inoculation to the mulched seedings gave an additional large increase in number of healthy plants. The subclover straw produced a satisfactory stand, which was much better than the uninoculated plots but inferior to the inoculated seedings.

The plots were harvested and the production of subclover forage determined. The plots that were not inoculated produced 60 to 100 pounds of dry matter an acre. The inoculated plots produced approximately seven times that amount of forage, and the mulched plots that were inoculated produced a further large increase in yield.

Approximately 50 plants were removed from each plot and their roots examined for nodules. The healthy plants had large pink nodules clustered near the main root

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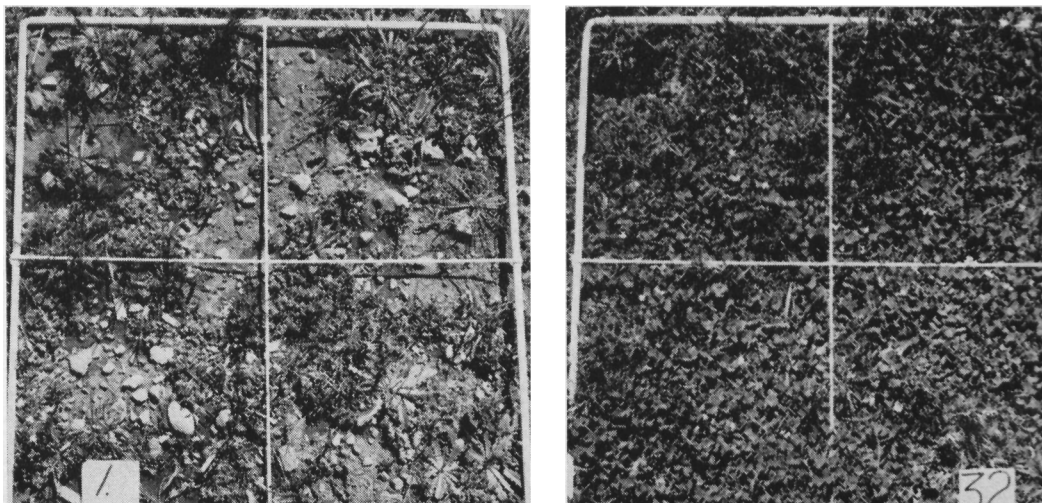
Subclover plant, *left*, not inoculated; *right*, inoculated. Arrow indicates nodules stimulated by nitrogen-fixing bacteria.

Effect of Simulated Straw Treatments on Subclover Plant Population, Forage Yield, Nodulation, and Nitrogen Content

Treatment	Healthy plants	Dry-matter yield	Plants effectively nodulated	Nitrogen content
	No./sq. yd.	lbs./A.	%	%
Seed Only	17	100	6	2.2
Mulch	16	60	3	2.2
Inoculation	105	690	60	3.4
Mulch and Inoculation	253	1,460	58	3.1
1,000 lbs./A. Subclover Straw	76	510	67	3.3

***Left*, subclover seeding without inoculation. *Right*, subclover seeding inoculated with proper legume bacteria.**



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SUBCLOVER

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indicating the presence of effective nitrogen-fixing bacteria. The stunted, poorly colored plants had no or small nodules scattered on the lateral roots, suggesting the presence of parasitic or ineffective nitrogen-fixing bacteria. On the inoculated and straw-treated plots 58% to 67% of the plants were effectively nodulated; the uninoculated plots contained only 3% to 6% plants effectively nodulated.

The plants were then analyzed for total nitrogen. The clover from plots that were ineffectively nodulated contained 2.2% nitrogen. Plants from the inoculation and straw-treated plots, which had a high percentage of effective nodulation, contained from 3.1% to 3.4% nitrogen, a gain of about 50%. Hence, the uninoculated plots were nitrogen-starved because the legume bacteria existing in the soil were not a highly effective nitrogen-fixing strain.

Fresh inoculum must be used and the seed must be properly inoculated to insure against possible failure of a stand of subclover because of a lack of sufficient numbers of the proper strain of nitrogen-fixing bacteria. The name of the plant to be inoculated should be listed on the container of commercial inoculum since various legumes require different strains of bacteria. The inoculum is mixed with water so that it will adhere to the seeds. For 100 pounds of seed approximately one quart of water is needed. The mixture is poured on the seeds, and mixed until all seeds are coated. The seeds are sown as soon as they are dry enough to run freely. If the seed is not sown the same day as inoculated, it should be inoculated again just prior to sowing. Inoculation is most likely to be successful when seed is sown in moist soil and covered. Hazards to legume bacteria are exposure to sunlight, drying, and high temperatures.

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