Salt Tolerance of Alfalfa Varieties

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SALINITY is a serious threat to crop production on the irrigated lands of the west. Approximately 20% of the 26 million irrigated acres in the 17 western states are used for alfalfa production (1). Most observations have indicated that alfalfa has better than average salt tolerance (5, 6, 8, 9, 12), but little information is known concerning the relative salt tolerance of alfalfa varieties and/or the influence of salinity upon the various growth criteria of the crop. This study was therefore designed to determine the effect of increasing levels of salinity on the growth, survival, and chemical composition of selected varieties of alfalfa.

The varieties selected for this study were: California Common 43116, Ladak, Turkestan FC 19316, A204 Syn 1, India FC 31902, and Atlantic FC 23206. California Common is a variety of Chilean origin adapted to the climate of California. India is a high-yielding, heat-resistant variety characterized by its quick recovery after cutting and long growing season. Turkestan is a long-lived, cold-resistant variety introduced from Turkestan which has shown considerable resistance to bacterial wilt. Atlantic is a vigorous high-yielding variety of mixed parentage which is adapted to areas of the eastern United States where bacterial wilt is not a serious factor. A204 Syn 1 is a synthetic variety originated in Nebraska. Ladak is a winter-hardy variety introduced from Kashmir which has proved superior to other varieties in many tests under cold and dry conditions of the Northern Great Plains.

METHODS

This study was started in 1947 and continued for three cropping seasons, using the salinized soil plot technique described by Wadleigh and Fireman (11). The alfalfa was grown in four 14 foot plots in a Latin-square design having 6 rows of 6 subplots with 4 plants of each variety per subplot. Each main plot was surrounded by border plants. Three plots were artificially salinized by irrigating with water containing 3,000, 6,000, and 9,000 ppm, respectively of added salt, and the control plot was irrigated with Riverside irrigation water (450 ppm). The salt was added as a 50:50 mixture by weight of sodium and calcium chloride in order to minimize toxicity of either sodium or calcium ions, and to avoid the deterioration in soil physical condition associated with abnormally high exchangeable-sodium-percentages (ESP). The average ESP of all salt plots was 10, 14, and 16 in the first-, second-, and third-foot depths, respectively. Five inches of water were applied at each irrigation, which was sufficient to wet the top 3 feet of soil. The plots were irrigated when the soil-moisture tension at the 2-foot depth reached 500 cm. in the control plot. The soil-moisture tension at the time of irrigation averaged 400, 350, and 300 cm. in the plots receiving 3,000, 6,000, and 9,000 ppm. of salt respectively. Fertilizer salts were added equally to all plots.

Four soil cores per plot were taken at intervals throughout the growing period, and the electrical conductivity of the saturation extract (EC.) was determined. The electrical conductivities of the 4 irrigation waters used in this study and the average EC. values of the soil, 2- to 40-inch depth, for plots irrigated with them are given in table 1.

The average EC. values varied but little from year to year although there was considerable seasonal variation within treatments. EC. values were lower in the spring following winter rains, and were higher in the summer and fall. Some variation in EC. was found with depth of soil, but after irrigations the salt content was relatively constant, increasing gradually down to the sixth foot where, by September 1949, EC. values of 9.0, 12.6, and 14.8 were found in the 3,000, 6,000, and 9,000 ppm. treatments respectively.

Individual subplots were harvested at 1/2 to 1/2 bloom and dried in a forced-draft oven at 85°C. Samples of dried material from selected harvests were saved for chemical analysis. Sodium, calcium, potassium, and magnesium were determined by the methods in use at the Salinity Laboratory (10) after wet digestion of the dried plant material with nitric and perchloric acids (7). Carotene was determined by the method of Zscheile and Whitmore (13).

RESULTS

The plants on the salinized plots were smaller and had a dark blue-green color which became more evident with increasing salt concentration, but in other respects the plants appeared to be normal and there were no symptoms of leaf burning or necrosis. The plants which died during the course of the experiment had produced progressively fewer shoots after each cutting until finally none developed.

The plants on the salinized plots bloomed a few days earlier than those on the control plot, and most varieties produced one cutting per year more on the salt plots than on the control plot. There was considerable seasonal variation in yield. India and California Common bloomed in April, a week earlier than the other varieties, and continued to grow later in the fall. They also resumed growth more rapidly and produced more cuttings than any of the other varieties. Alfalfa varieties are known to vary widely in their photoperiodic response, and it seems probable that the four other varieties were more sensitive to short days, resulting in a markedly decreased rate of growth in the fall, even though temperature and other environmental conditions were favorable.

The yields of the 6 varieties for the 3 years expressed on a dry-weight basis are shown in figure 1.

The largest cuttings of all varieties were made in the spring, with gradual reduction in yield in successive months. The yields on the salt plots were reduced more during the summer than were the yields on the control. For