CROP PLANTS - WATER USE AND SALT TOLERANCE

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This is a discussion and presentation of data regarding the amount of water used by crop species and water used by different plants within a species. Salt tolerance among and within crop species is also discussed. Only selected references are used for illustration and therefore many references that relate to this subject are omitted. The inherent plant differences are of primary concern here.

Consumptive use (evapotranspiration) values have been measured and estimated for various crops by several methods. These values give some indication of water needed by various species to maintain growth and development during a growing season. Since these figures include only estimations of evaporation and transpiration losses and do not include other necessary losses, they should be used only as a guide as to which crops need more of less water. Table 1 shows measured consumptive use values for several crops grown at different locations.(2)

These measured consumptive use values provide an indication of the relative water need of some crop plants. However, it would be desirable to have such values for a single location. Computed consumptive use values are available by locations. An example is shown in Table 2. These computed values are considered for Deming, New Mexico and show a relationship of crops to water use similar to Table 1. (3)

Even though these consumptive use values do not include necessary water "loss" such as leaching, conveyance and application, they may help decide the crop to be grown if water is limiting. For more detailed information on consumptive use of water by crops and how this information can be applied to irrigation practices see Blaney and Hanson (3) and Erie, French and Harris (5).

More realistic measurements of actual water necessary to produce high yields are demonstrated by unpublished data from Professor Hanson (6). Alfalfa responded as shown in Table 3 to high, medium, and low irrigation levels. This experiment was conducted on a highly productive soil with adequate fertility for the expression of high yield.

Even though the highest yields were obtained from the high irrigation treatment, it appears very important that pounds of alfalfa

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TABLE 1. Examples of Seasonal Consumptive Use of Water by Various Irrigated Crops as Determined by Field Experiments in Western United States (2)

	Growing Season or Period		Consumptive Use	Location
	Dates		Total Inches	
Alfalfa	4/10	10/31	38.0	State College, N.Mex.
Cotton	4/1	10/31	26.9	State College, N.Mex.
Citrus Trees	4/1	10/31	20.6	Los Angeles, Calif.
Corn	3/15	7/15	20.0	Mercedes, Texas
Potatoes	5/1	9/30	19.9	San Luis Valley, Colo.
Sm. Grain (sp.)	5/25	8/21	16.6	Vernal, Utah
Beans	6/1	9/30	14.4	Davis, California

Note that the consumptive use values shown here consider only the growing season and do not take into account water necessary for maintaining perennial plants during the winter.

TABLE 2. Example of Computation of Seasonal Consumptive Use for Crops Near Deming, New Mexico (3)

Crops	Length of Growing Season or Period		Consumptive Use Amount
			Inches
Alfalfa	4/15	10/29	36.01
Cotton	4/15	10/29	26.27
Corn	6/1	10/15	23.11
Sorghum	6/1	10/15	21.57
Sm. Grain (sp.)	3/10	7/1	15.58
Beans (dry)	6/15	9/15	13.15

TABLE 3. Average Alfalfa Yield by Irrigation Treatments in Relation to Yield per Acre-Inch of Water Applied in 1961, 1963, and 1964 - University Park, New Mexico (6)

Irrigation Treatment	Water Applied*	Yield	Yield/In. of Water Applied
	Inches	Tons/Acre	Pounds
High	89	12.1	272
Medium	82	11.0	268
Low	68	8.8	259

*Including rainfall

produced per inch of water applied is not lower for the medium and low irrigation treatment. Professor Hanson has summarized this as an indication that if water is limiting for alfalfa forage production, it may be advisable to reduce acres rather than attempt to apply a low amount of water to more acres.

More data such as shown in Table 3 for specific crops at several locations are desirable to determine the water necessary to allow a crop variety to express its inherent maximum water use efficiency.

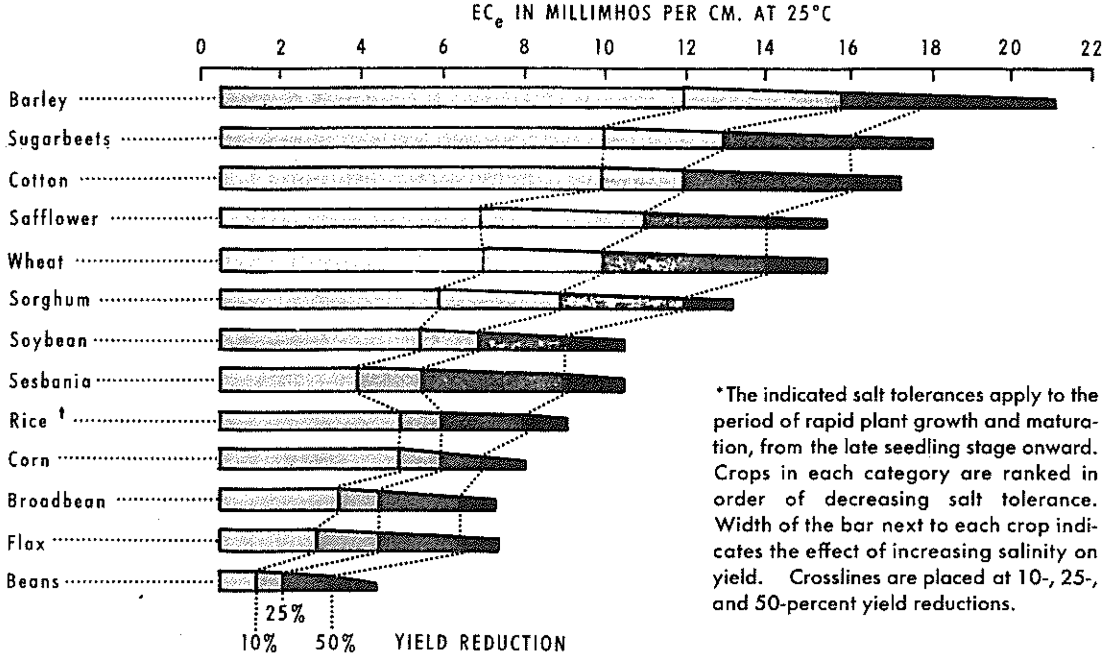
Of less interest to producers, but important to agronomists is - can strains be developed which use water more efficiently? There are indications this is possible simply by breeding for increased yield. Table 4 shows large differences among orchardgrass genotypes for units of water necessary to produce a unit of dry matter (7). This greenhouse experiment showed a high, negative correlation between water requirement and yield. However, as water becomes more valuable, it may be necessary to determine if agronomically desirable strains can be selected for higher water use efficiency without changing yield.

That certain crop plants are less sensitive to high concentrations of soluble salts in the root medium (or salt tolerant) is well known. Tables 5 and 6 graphically show the relative salt tolerance of field crops and vegetable crops respectively (1). Difference among crops are very important to producers contending with high concentrations of soluble salts. However, another point of interest is the inherent differences that may exist among strains or genotypes for salt tolerance. Several workers have measured the response

TABLE 4. The Water Requirement (X/Y), Dry Weight Yield in Grams (Y), and Water Used per Plant in Grams (X). The Data are from 16 Genotypes of Orchardgrass and are Based on 66 days Growth in Gallon Cans (7)

Genotype	Number of Replications	Water Requirement (X/Y)	Yield (Y)	Water Used (X)
8	23	670	5.09	3411
17	24	753	4.35	3272
16	24	764	4.28	3271
7	19	769	3.18	2447
12	22	776	3.60	2798
15	24	792	3.97	3147
10	23	799	3.49	2790
6	24	808	3.50	2827
9	24	835	3.74	3122
5	24	836	3.45	2889
2	23	843	3.44	2899
14	21	891	2.61	2329
1	23	901	3.08	2769
11	22	958	3.01	2887
3	24	995	3.01	2999
4	23	1082	2.79	3016
Mean		842	3.54	2930

TABLE 5. SALT TOLERANCE OF FIELD CROPS* (1)



*The indicated salt tolerances apply to the period of rapid plant growth and maturation, from the late seedling stage onward. Crops in each category are ranked in order of decreasing salt tolerance. Width of the bar next to each crop indicates the effect of increasing salinity on yield. Crosslines are placed at 10-, 25-, and 50-percent yield reductions.

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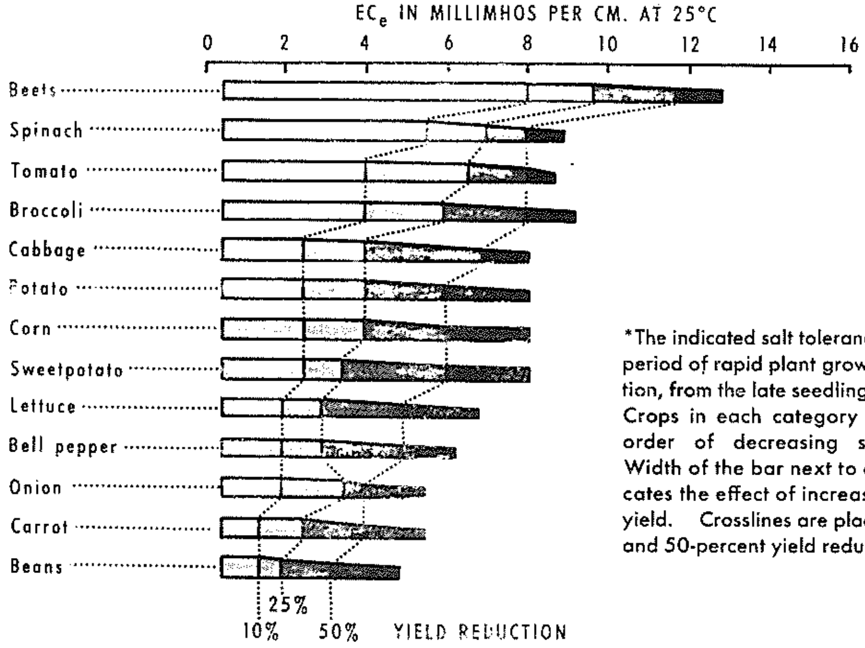
TABLE 6. SALT TOLERANCE OF VEGETABLE CROPS*(1)



*The indicated salt tolerances apply to the period of rapid plant growth and maturation, from the late seedling stage onward. Crops in each category are ranked in order of decreasing salt tolerance. Width of the bar next to each crop indicates the effect of increasing salinity on yield. Crosslines are placed at 10-, 25-, and 50-percent yield reductions.

of strains within species for tolerance to high salt. For example, Dewey (4) working with wheatgrass and Tromble (8) working with bermudagrass and blue panicgrass found large differences among strains for germination percentage in high salt content solutions. Figure 1 and Figure 2 graphically show the large germination salt tolerance differences found in blue panicgrass and bermudagrass. Similar data has been collected for cotton, alfalfa, and other crops. Such data indicate it should be possible to breed for increased salt tolerance for the germination stage of growth. However, to the author's knowledge, no salt tolerant varieties have been released as a result of concentrated selection for this characteristic. If failure to get a stand under high saline conditions becomes economically more important, it may be necessary to develop varieties with higher germination salt tolerance. Although mature plant salt tolerance may not be highly correlated with germination salt tolerance, there are indications that salt tolerance at the mature plant stage can also be increased by selection.

SUMMARY

Consumptive use measurements are available or can be computed to serve as a guide to relative water use by crop species. However, more research is needed to determine the irrigation level necessary to give the greatest water use efficiency for specific crops grown under specific environments.

Crop response to various concentrations of soluble salts is relatively well known. The performance of strains and genotypes within a species to high concentrations of salts is less well known. However, data now available for several species indicate it should be possible to breed for increased salt tolerance, especially in the germination stage of plant growth.

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Fig. 1. A graphic comparison of the mean adjusted germination percent of each of the 15 accessions of blue panicgrass at three salt concentration levels (8).

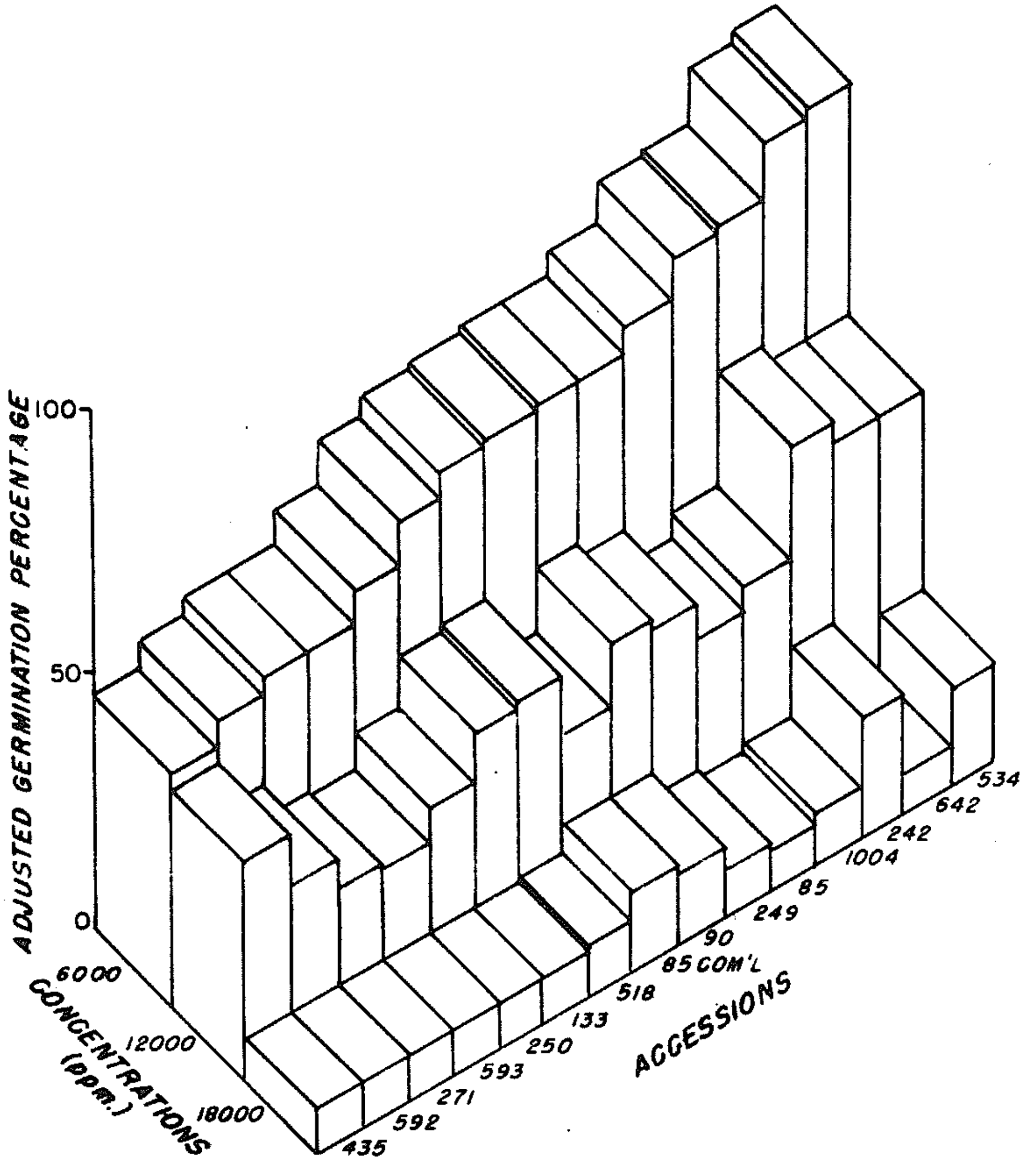
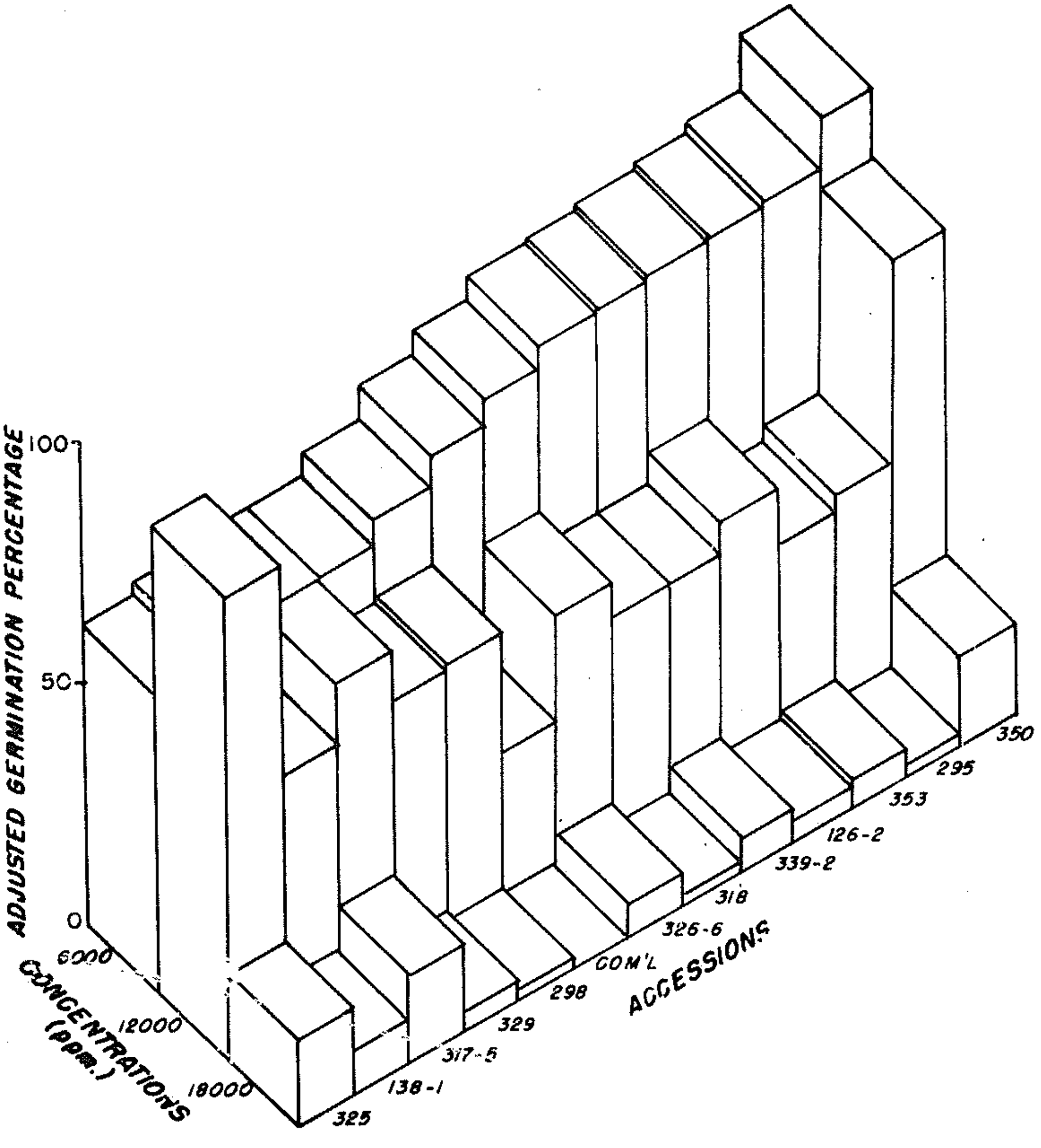


Fig. 2. A graphic comparison of the mean adjusted germination percent of each of the 13 accessions of bermudagrass at three salt concentration levels (8).



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