Soil Salinity as Related to the Growth and Development of Crops on Leached Soils

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Effects of salts on farm crops have been intensively studied (Rozov, 1934; Kovda, 1947; Genkel, 1954; Stroganov, 1962; Shakhov, 1956; Burygin, 1952; Azizbekova, 1964; Abutalybov, 1939; Muradova, 1956; Nerozin, 1968; Alekperov, 1965; Alekperov, 1958; Mamedov, 1967; Belkina, 1963; Lifshits, 1961). The salt resistance of different crops, including cotton, has been found to vary depending on the type and texture of the soil, its moisture content during the vegetative period, its stock of nutrients, local climatic conditions, and crop variety. It is important to determine salt-resistance values for different natural zones and areas and locally prevailing soil-climatic and agricultural conditions.

On improving saline soils it is very necessary to determine the maximum permissible level of soil salinity, beyond which crops are no longer able to grow and develop normally.

The salt resistance and productivity of farm crops was studied by the author of this paper on saline soils in the area of the Zonal Experimental Station, Lenin Collective Farm, Ujar District, on the Shervan steppe in Azerbaijan. According to salinity type, the local soils are chloride-sulphate, according to texture, clayey and heavy-loamy.

It was shown that on soils of low salinity (0.11 – 0.23 per cent of solid residue), cotton stands developed normally and, intensively increased their dry weight in both separate parts and the plant as a whole. Where the concentration of non-nutritious salts in the 100 cm-deep layer of soil rose to 1 % on the average, the growth and development of cotton was badly inhibited. On medium-saline soils cotton stands somewhat adapted to salinity and reached a certain degree of development, but if germination was supressed productivity was acutely impaired at a 1 per cent concentration, soil salinity thinned the stands and reduced the per hectare yield of raw cotton by 27 – 34 per cent.

Maize had a much lower salt resistance than cotton. Yet, a 0.05 per cent content of chlorine and a 0.4 – 0.5 per cent content of solid residue in the soil were not critical to maize. With increasing solid residue, maize yields fell sharply compared with those on non-saline soils, where the crop yielded up to 600 centners of green matter per hectare.

In a test in 1955 under conditions of lower soil salinity (0.23 per cent of solid residue), maize developed normally and produced big, well-shaped cobs. The data obtained favour the conclusion that the soils of Shirvan should

Table 1

Green yield of annual fodder crops depending on the degree of soil salinity

Crop	Salinity in terms of solid residue,** %	Green yield, cent/ha			Decrease in yield with varying salinity, %
		first cutting July 28	second cutting Sept. 17	total	
Sudan grass	0.031—0.46	130.7	92.0	222.7	—
	0.042—0.82	123.0	67.5	190.5	14.2
	1.63	42.5	50.0	92.5	58.5
Sweet sorghum*	0.34	286.0	—	—	—
	0.73 —0.75	218.5	—	—	23.8
	1.13	147.2	—	—	48.6
Sunflower	0.59 —0.62	234.0	—	—	—
	0.74 —0.83	149.0	—	—	36,4
	1.29 —1.54	74.5	—	—	68.2
Green bristol grass	0.43 —0.57	158.8	—	—	—
	1.06	41.0	—	—	—

* Harvested on August 21.
** Solid residue from 1 : 5 soil: water extract.

have a solid residue not exceeding 0.5 per cent and a chlorine content not exceeding 0.05 per cent for growing maize either for grain or forage. If a soil has a solid residue less than 0.5 per cent, it should be possible to harvest from 349.6 to 477.3 centners of green maize per hectare.

Mixed grass stands should grow unless the solid residue exceeds 0.7—0.8 per cent in the 20 cm deep layer and 0.09—1.3 per cent in the metre-deep layer. To obtain vigorous germination of grasses, the content of chlorine in the arable layer should not exceed 0.045 per cent. While improving saline soils, the fertility may be improved by sowing grass mixtures on newly leached areas.

Salinization can also be effectively controlled by growing annual fodder crops. To this end, prospective annuals from other climatic zones were tested at Shirvan. They were planted on saline soils after leaching. Sweet sorghum proved to be extremely salt-resistant. Sudan grass was also fairly salt-resistant. However, on a plot with a 2.2— 2.8 per cent salinity, it failed to germinate. Green bristol grass and sunflower proved to be much less resistant to salts. They thinned-out by the end of the growing season. The growth rate of crops was evaluated by periodically measuring their height. The growth of sudan grass was inhibited when salinity increased from 0.3 to 1.6 per cent in terms of solid residue. Sunflower and green bristol grass were even less immune to changes in salinity. When the salt content in the soil reached 1.05 per cent the stands were twice as high on non-saline plots as on saline ones.

Green yields were calculated for cereals harvested at the early heading stage and for sunflower harvested during the early vegetation period. It was found that on badly saline soils (salt content being equal to 1.6 per cent and 1.3 per cent respectively), the green yield of sudan grass dropped by 58.5 per cent, while that of sweet sorghum dropped by 48.6 per cent (Table 1). There was a large decrease in the yield of sunflower even with moderate salinization. Green bristol grass was even more sensitive to salinization.

Table 2

Growth and development of jugara depending on the salinity degree of the soil*

Origin of soil samples	Solid residue, %	Chlorine content, %	Height of stands, cm	Green-mass yield, centn./ha
Plot with very well developed crops	0.76	0.016	226	668
Plot with well developed crops	0.95	0.020	187	502
Plot with poorly developed crops	1.50	0.027	152	3.58
Plot without germination	3.41	0.116	—	—

* Soil samples were taken to a 30 cm-deep layer on August 27, 1962.

Thus, sweet sorghum and sudan grass can be sown on leached soils of the Shirvan Steppe to advantage, because they are the most effective of all the annuals for soil reclamation.

Also of interest is the effect of salinity on the development of jugara *(Sorghum cernuum)*. It was established that soils of the chloride-sulphate salinity type with a chlorine content of 0.016 per cent and a solid residue of 0.76 per cent were still able to produce jugara (Table 2).

An increase in solid residue from 0.95 to 1.50 per cent and chlorine content from 0.02 to 0.027 per cent resulted in the crop being inhibited and in the yield being decreased. On the most saline areas jugara did not germinate at all.

With the salinity now prevailing, jugara may be grown to advantage over vast areas in the Shirvan locality. Owing to its exceptionally well developed root system, jugara manages to survive even on solonchak soil.

Jugara also surpasses other salt-resistant crops by its ability to quickly shade the soil surface and maintain its protective cover well into the autumn. This is very important as it prevents the salts from moving back into the arable layer. When jugara ripens its stalks and leaves still remain green. The growing of jugara for animal feeds on the Shirvan Steppe is possible on slightly or medium saline soils without preliminary leaching.

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