IRRIGATION WATER AND RELATED GOLF COURSE PROBLEMS IN THE CHICAGO AREA

By V. J. Zoiman

Experts in golf course maintenance frequently mention the role of irrigation water in establishing a healthy turf. However, the usual emphasis is on water as a solvent for chemical compounds in the soil, or as a transporter of nutrients within plants or as a prerequisite for metabolism and normal growth of grasses. Seldom considered are ingredients and chemical compounds applied to lawns in irrigation water. Yet, these compounds, having once reached a certain degree of concentration in the soil, may critically influence the general soil environment and the growth of grasses.

Golf courses, mostly for business purposes, are located around big cities. They were usually established on small running waters or near artificial lakes to provide a variety of playing conditions, pretty scenery—and irrigation. Very often overlooked is the fact that newly developed housing and industrial plants in the area may cause the water used for irrigation to become polluted with wastes, salts and detergent residues. Repeated application of such water may lead to accumulation of harmful chemicals in the soil. Thus, in many instances, the turf problems of a golf course around a big city may be intimately associated with irrigation water. Lake Michigan water has the content of Epsom Salt close to standard.

Irrigation Water and Disease Problems

Potentially harmful effects of irrigation water have been acknowledged by several scientists and research stations. It has been pointed out that if soil and climatic conditions (such as high temperature, soil moisture and humidity) are favorable, then

> " . . . the majority of disease-causing organisms exist in both parasitic and saprophytic stages and are known as faculative organisms. The fungi known to be most damaging to grasses subsist in dead organic matter such as mat and thatch as well as on live grass plants. They are constantly present and may become actively parasitic on a grass plant, if the plants lose vigor . . .
>
> If irrigation waters contain ingredients such as chemical waste, salts or other chemical compounds which are toxic even to minor degree to a grass plant, the plant may be damaged to the point that it loses disease resistance and is thus subject to attack by the constantly present fungi. Once the balance between plant resistance and susceptibility is tilted in favor of the fungus, disease conditions can reach the epiphytotic proportions. If at any time there is evidence that the supply of water is damaging to existing turf such water should be tested immediately."*

Irrigation Water Standard

The United States Government has established certain general standards for water used in agriculture. According to these standards chemical compounds may not exceed specific limits without becoming harmful. These are shown in Table I below. In respect to golf courses, the Brookside Research Laboratories generally accept the Government standards but emphasize as very important the following chemical limits in irrigation water:

Epsom Salt, (MgSO4 - Magnesium Sulphate): 100.0 ppm

Total Sulphate (SO4): 250.00 ppm; Total Chlorides (C1): 250.00 ppm

Boron (B) 2.00 ppm

The chemicals in excess of these quantities may become toxic to fine turfgrasses.

In the course of my research of the turf problems of certain golf courses in the Chicago area, I have conducted several chemical analyses of the water used for irrigation. The range of main chemical compounds found in irrigation waters is shown in Table I, Column C. As may be seen from that table, most irrigation waters differ to some degree in concentration of Epsom Salt (MgSO4) and Total Sulphates (SO4) or Boron (B), some common salt (NaC1) and Chlorides (C1). Very often, irrigation water has a toxic effect due to the combination of two or three harmful chemical compounds.

TABLE I

Comparison of U. S. Government and Brookside Research Institute Standards with the Results of Analysis of Irrigation Waters in Chicago Area Golf Courses

Chemical Substance[1]	U.S. Gov. Standard (A)	Brookside Lab Standards (B)	Range of Actual Findings[2] (C)
	Concentration mg/L or ppm		
EPSOM SALT (MgS04)	-	100.00*	34.60 - 341.50
ARSENIC (As)	.01	.01	
TOTAL SULFATE (SO)	250.00	250.00*	11.50 - 441.10
COPPER (Cu)	1.00	1.00	
CYANIDE (CN)	.01	.01	
IRON (Fe)	.30	.30	
MAGNESIUM (Mg)	125.00	125.00	
MANGANESE (Mn)	.05	.05	00.00 - .03
NITRATE (NO_3)	45.00	45.00	
NITRITES (NO_2)	-	-	
TOTAL CHLORIDES (C_1)	250.00	250.00*	13.20 - 544.00
ZINC (Zn)	5.00	5.00	
FLUORIDES (F)	1.00	1.00	
BORON (B)	-	2.00*	.39 - 8.60

1 Total Solids should not exceed 500.0 ppm.

2 From 28 irrigation water analyses and from 22 golf courses.

* Emphasized as particularly important.

Toxicity Increase During Dry Period

Toxicity usually incerases during a dry period in the summer months because water is the minimum factor in the soil and turfgrasses require more irrigation during high temperatures. This is generally true for well water where the concentration during the year has changed very little. Running waters as in brooks, creeks and canals are usually of double or higher concentration in summer, when level of water and clarity decrease and concentration increases. The changing pattern of toxicity found in one particular case is shown in Table II.

TABLE II

Concentration of Chemical Substances In Irrigation Water Over Time

Time	$MgSO_4$ Epsom Salt	SO_4 Sulfate	NaCL Common Salt	Cl Chloride	B Boron	Level of Water
	ppm					
June 28, 1965	237.60	252.40	74.2	74.2	204	High
July 29, 1965	341.50	441.10	105.6	105.6	198	Low

Chemical Relationships Between Irrigation Waters and Top Soil of Greens

Relationships of certain substances or elements between irrigation waters and soil on greens are more evident if water is used for irrigation during several years. Under such circumstances, chemical substances accumulate and may reach toxic levels. Furthermore, there exists a positive correlation between levels of common salt (NaC1) found in irrigation water and high sodium (Na) found on greens. This is illustrated in Table III. High content of NaC1 (399 ppm) was found in water and a range 6.46 - 7.63% of Base Saturation of Sodium (Na) was found on Course I. Similarly, on Course II 46.20 ppm common salt (NaC1) in water was found to be accompanied by 4.21 - 5.79% of Na. On the Course III, where the level of common salt in water was found to be 19.80 ppm the base saturation level of Sodium (Na) was only 1.18% in the soil.

TABLE III

Chemical Substances In Irrigation Waters and Their Connection on Greens of Three Courses on One Golf Club

Sources of water	$MgSO_4$ Epsom Salt	SO_4 Sulfate	NaCl Common Salt	Cl Chlorides	B Boron	Range of Sodium[1] % (B.S.)	Different Courses
	ppm						
Well	34.60	116.00	19.80	19.80	2.10	1.18-1.64	III
Northlake	111.50	111.50	46.20	54.00	1.56	4.21-5.79	II
Southlake	170.40	170.40	399.30	544.30	1.53	6.46-7.63	I

1 Standard range .5 - 3%

Similar positive correlation is shown between Epsom Salt (Magnesium Sulfate - MgSO4) in irrigation water and high contents of Magnesium (Mg) and Sulphate (SO4) in soils and greens. This is illustrated in Table IV. Epsom Salt i.e. Magnesium Sulfate (MgSO4) 341.50 ppm and Magnesium (Mg) 30.87 - 36.92% (B.S.) (Standard range 10 - 20%) and Sulfate (S) 2,574-4,509 lbs. per acre. Only two greens were below the 3,000 pounds per acre of sulfate considered to be detrimental to grasses.

TABLE 4

Relationship Between Epsom Salt and Sulfate Concentration In Irrigation Water and Sulfur and Magnesium Contents of Soils

	IRRIGATION WATERS					RANGE IN SOIL ON GREENS	
Sources of water	Epsom Salt $MgSO_4$	Sulfate SO_4	Common Salt NaC1	Chlorides CL	Boron B	Sulfates S[1]	Magnesium Mg^2
	ppm					Lbs per acre	% B. S.
Brook	341.50	441.10	105.6	105.6	1.98	2,514-4,509	30.83-36.90
Well	123.70	301.30	13.20	13.20	4.2	--	--

1 3,000 lbs./acre may be detrimental.
2 10-20% (Base Saturation) is standard range.

Dealing with the Problem

In cases analyzed, the main problems of irrigation waters were mostly chemical substances as Sulfate, Chlorides and trace minerals such as Boron. Unfortunately, we have no economically feasible methods for chemical removal of Sulfate and Chloride compounds from irrigation water. Fortunately, in both cases analyzed, there were better sources of irrigation water in the area. (See Table III and IV). It was possible to recommend discontinuation of use of chemically-defective waters and another source was substituted.

In general, two ways of dealing with the problem are possible, once the chemical analysis reveals presence of chemically-defective matter; one, as followed in cases discussed above, is to substitute new and better source. Alternatively, superintendents can reduce (or even eliminate) some harmful effects of irrigation water by proper maintenance of courses in conformity with natural chemical laws. This means a corrective fertilization program for balancing soil environment, based on scientific principles.

Chemical compounds and their concentration in irrigation waters are important factors which must be considered for the nutrition and healthy growth of fine turf grasses — sensitive monoculture — on golf courses in Chicago area.

* James L. Holmes, "Factors Influencing Irrigation", **USGA Green Section Record,** Vol. 3, No. 6 (March 1966) page 7.