Water quality of major irrigation tanks in Sri Lanka

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ABSTRACT

WATER samples from fifteen major irrigation tanks in Sri Lanka were chemically analysed. Some waters contained significant qualities of potassium, calcium and magnesium. The silica content of irrigation water was low. The chloride content of some water was so high as to be considered undesirable for cigarette tobacco cultivation. The waters did not possess a sodium hazard. Some tanks contained medium salinity irrigation water.

INTRODUCTION

Most of the water in an irrigation tank is brought in during the rainy season. However, only a small portion of the tank water is obtained by direct precipitation. The bulk of it comes from the catchment area. As this water flows into the tank it brings dissolved material by contact with soil, rock and other inorganic and organic substances.

Irrigation water may benefit crops by supplying certain plant nutrients. On the other hand, a saline water or a high sodium water may be harmful. Irrigation water quality is an important parameter which may determine the sustenance of an irrigated agricultural system. This paper describes the chemical characteristics of the irrigation waters from some of the major irrigation tanks in Sri Lanka.

MATERIALS AND METHODS

The following tanks were included in this study: Iranamadu, Vavunikulam, Pavatkulam, Giant's Tank, Maha Willachchiya, Nuwarawewa, Nachchaduwa, Kalawewa, Huruluwewa, Kantalai, Minneriya, Parakrama Samudraya, Rukam, Unnichchai and Senanayake Samudraya. All these tanks are situated in the dry zone of Sri Lanka receiving an annual rainfall of about 60 to 180 cm.

Frequency of sampling

The water was sampled once a month beginning August, 1965 for a period of twelve continuous months.

Analysis

On reaching the laboratory the water was filtered and the filtrate was used for analysis. Five ml. chloroform was added to prevent fungal growth. The following determinations were made from every sample of water: pH, electrical conductivity, sodium, potassium, calcium, magnesium, chloride, sulphate, bicarbonate and silicon. The analytical methods used were identical to those described by Amarasiri (1965).

RESULTS AND DISCUSSION

Table 1 gives the chemical analysis of the water from the fifteer tanks studied. Each value represents the simple average of the twelve determinations made each month of the year.

Nutrients supplied by irrigation water

The amounts of K, Ca, Mg, SO_4 and Si supplied by irrigation water is given in Table 2. This calculation is based on a supply of four acre feet of irrigation water. Such a value may be reasonable for rice (Murakami, 1966). Once the irrigation water usage of a particular crop is known the appropriate calculation can be made for this crop.

Potassium

The results show the wide variation in the amounts of potassium supplied by the tanks. They reveal for example, that crops grown under Senanayake Samudraya water may require more potassium as fertillizer than crops grown from Giant's Tank water. The low potassium content of waters in the tanks in the eastern part of Sri Lanka may be related to the low potassium containing acidic rocks found in this region.

Calcium

Irrigation water supplies large quantities of calcium. This nutrient is also added when superphosphate is added as a P fertiliser. From these two considerations one may not anticipate calcium deficiency occurring in most parts of the dry zone of Sri Lanka.

Magnesium

Magnesium is presently not added as a fertiliser in the dry zone. A 5 ton/ha crop of rice will remove about 25 kg/ha Mg (IRRI, 1963). The results in Table 2 show that irrigation water may be able to

supply some of the Mg requirements of rice. However, the Mg content of waters from some tanks, for example, Rukam, Unnichchai and Senanayake Samudraya are so low that it may be appropriate to investigate whether magnesium might be a limiting factor in growth of plants in these areas.

Sulphate

If urea, concentrated superphosphate and muriate of potash are used as fertiliser the crops will not receive any S in the form of a fertiliser. The S in irrigation water may be helpful in supplying the S requirement of plants.

Silicon

There are several benefits to rice from this element although it is not considered an essential nutrient. Some of these benefits are mobilization nof soil phosphorus, increasing the resistance of rice plants to blast disease and making the plants less vulnerable to insects such as stem borers (De Geus, 1970). A 5 ton/ha crop of rice may remove about 900 kg/ha Si (IRRI, 1963). From the data in Table 2 it is apparent that the contribution of silicon from irrigation water is quite low compared to the amount of silicon removed. This information suggests that investigations are needed to ascertain whether silicon has to be added to some of our rice fields regularly.

Chloride content of irrigation water

A high content of chloride in tobacco leaf causes poor burning. This factor is perhaps more important for cigarette tobacco than for other kinds of tobacco. Thomson (1966) reports that irrigation water containing 12-32 ppm Cl is unsuitable for tobacco cultivation. It is evident from Table I that some of the tank waters may not be suitable for tobacco. However, the chloride content of the irrigation waters of the eastern portion of the country is low.

Sodium hazard of irrigation water

Irrigation with waters of high sodium content may lead to the formation of soils which are hard when dry and sticky when wet. Tillage is very difficult with such soils. These soils also have restricted permeability of air and water.

The United States Department of Agriculture (1954) classifies irrigation water with respect to its Sodium Absorption Ratio (SAR). SAR is obtained from the following expression, all concentrations expressed in milli equivalents per litre :

$$SAR = \frac{Na+}{\sqrt{\left[\frac{1}{2}\left(Ca^{2}+ + Mg^{2}+\right)\right]}}$$

According to the United States Department of Agriculture classification, waters having an SAR value of 0-10 are considered low sodium water. The waters of the present study have SAR values ranging from 0.4 at Minneriya to 2.1 at Giant's Tank. Sodium in the irrigation waters in this study is thus unnlikely to present a problem.

Salinity of irrigation water

Use of a saline irrigation water may lead to the formation of a saline soil. Such soils are generally unproductive and also restrictive in the type of crops which can be grown. The United States Department of Agriculture (1954) has classified irrigation waters on the basis of electrical conductivity as follows :—

Conductivity micromhos/cm at 25°C	*Class*
0 – 250	.. low salinity water
250 – 750	.. medium salinity water
750 – 2250	.. high salinity water
>2250	.. very high salinity water

If this classification is adopted for the present study, Giant's Tank, Pavatkulam, Maha Willachchiya, Nuwarawewa, Kalawewa, Huruluwewa and Nachchaduwa have medium salinity water. Such waters can be used for the cultivation of crops with moderate salt tolerance if a moderate amount of leaching occurs. If drainage is restricted salinity could become a major problem of the irrigation schemes in the dry zone of Sri Lanka.

Seasonal variation of chemical constituents of irrigation water

The dry zone of Sri Lanka can be generally considered to consist of a wet season and a dry season. Table 3 gives the values for K and electrical conductivity of the waters for the two seasons. As a result of the much higher values for K during the dry season the crops growing during the dry season may require less potassium fertiliser than during the wet season.

The salinity level is also higher during the dry season. This may suggest that the salt tolerance of crops may have to be considered in determining the crops to be grown during the dry season. It may also require paying greater attention during the dry season to drainage of low-lying lands to prevent a build up of salinity.

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TABLE 1.—CHEMICAL ANALYSIS OF IRRIGATION WATER

Tank	*Capacity acre feet*	*pH*	*Electrical conductivity micromhos /cm 25°C*	*Na ppm*	*K ppm*	*Ca ppm*	*Mg ppm*	*Cl ppm*	*HCO_3 ppm*	*Si ppm*	*SO_4 ppm*
Iranamadu ..	82,000..	7·7..	224..	20·65..	6·20..	13·10..	8·05..	41·10..	73·55..	1·30..	3·5
Vavunikulam ..	40,000..	7·6..	237..	17·30..	6·60..	14·90..	7·95..	35·60..	81·05..	3·30..	4·0
Pavatkulam ..	27,000..	7·9..	555..	52·40..	12·05..	26·35..	22·75..	85·40..	193.90..	5·20..	8·0
Giant's Tank ..	26,600..	8·4..	665..	66·60..	15·80..	30·20..	28·90..	132·20..	189·70..	10·60..	10·5
Maha Willachchiya ..	28,300..	7·7..	508..	47·75..	11·20..	25·30..	18·40..	111·30..	114·85..	1·70..	4·0
Nuwarawewa ..	36,000..	7·8..	506..	41·65..	10·35..	32·15..	19·35..	121·60..	106·70..	4·00..	3·5
Nachchaduwa ..	45,100..	7·9..	344..	28·10..	8·60..	21·40..	11·80..	66·70..	94·80..	1·00..	3·5
Kalawewa ..	72,700..	8·1..	436..	34·00..	8·45..	28·10..	16·75..	56·95..	167·95..	4·80..	5·5
Huruluwewa ..	55,000..	7·7..	367..	27·80..	9·20..	24·55..	13·95..	60·25..	130·85..	1·85..	3·0
Kantalai ..	90,000..	8·0..	218..	9·85..	5·05..	17·65..	10·10..	15·80..	120·45..	4·80..	4·0
Minneriya ..	110,000..	8·2..	240..	10·15..	4·20..	24·05..	13·25..	13·80..	153·70..	6·70..	3·5
Parakrama Samudraya ..	82,000..	8·2..	221..	8·50..	3·55..	22·40..	9·45..	8·65..	135·25..	9·55..	3·0
Rukam ..	16,100..	7·8..	78..	6·90..	3·50..	4·35..	2·55..	10·25..	32·20..	5·80..	5·5
Unnichchai ..	30,500..	8·0..	76..	5·00..	2·90..	4·70..	1·60..	7·05..	35·65..	4·70..	4·0
Senanayake Samudraya ..	770,000..	7·7..	80..	4·50..	2·85..	6·50..	3·10..	4·55..	52·60..	8·50..	3·5

TABLE 2.—NUTRIENTS SUPPLIED BY IRRIGATION WATER (KG/HA)

Tank	*K*	*Ca*	*Mg*	*S*	*Si*
Iranamadu	75·5	160·0	98·2	14·2	15·9
Vavunikulam	80·4	182·0	97·0	16·2	40·1
Pavatkulam	147·0	321·0	277·0	32·5	63·4
Giant's Tank	193·0	368·0	352·0	42·6	129·4
Maha Willachchiya	136·0	309·0	224·0	16·2	20·7
Nuwarawewa	126·0	393·0	235·0	14·2	48·8
Nachchaduwa	105·0	261·0	144·0	14·2	12·2
Kalawewa	103·0	343·0	204·0	22·3	58·5
Huruluwewa	112·0	299·0	170·0	12·2	22·5
Kantalai	61·5	215·0	123·0	16·2	58·5
Minneriya	51·2	294·0	162·0	14·2	81·7
Parakrama Samudraya	43·3	273·0	115·0	12·2	116·4
Rukam	42·6	53·0	31·1	22·3	70·7
Unnichchai	35·3	57·3	19·5	16·2	57·3
Senanayake Samudraya	34·7	79·3	37·8	14·2	103·6

TABLE 3.—SEASONAL VARIATION IN POTASSIUM CONTENT AND IN ELECTRICAL CONDUCTIVITY OF IRRIGATION WATER

Tank	*K ppm*		*Electrical conductivity micromhos/cm at 25°C*	
	Wet season *	*Dry season* †	*Wet season* *	*Dry season* †
Iranamadu	4·7	10·7	161	286
Vavunikulam	5·3	10·4	189	293
Pavatkulam	5·9	30·0	346	797
Giant's Tank	6·0	35·8	325	908
Maha Willachchiya	6·9	24·2	278	604
Nuwarawewa	7·1	21·7	326	599
Nachchaduwa	6·2	14·9	196	422
Kalawewa	5·7	17·2	278	556
Huruluwewa	7·6	13·5	236	388
Kantalai	4·4	7·0	163	286
Minneriya	3·5	6·7	191	312
Parakrama Samudraya	3·2	5·5	175	263
Rukam	2·6	5·4	61	96
Unnichchai	2·1	3·6	44	60
Senanayake Samudraya	2·8	3·6	72	84

* Average values for December, January and February.

† Average values for June, July and August.