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Quality management of irrigation water through native tree materials

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Abstract : Laboratory experiments were conducted to study the effect of amla tree dried lopping on the improvement of irrigation water quality. The irrigation water from three different sources, with varying water quality and distilled water as control was treated with amla *(Pyllanthus emblica)* tree dried lopping at four concentration levels viz., 0, 5, 10 and 15 percent. The study was conducted in FRBD with three replications. The results clearly indicated that treatment of amla tree dried lopping at varying concentrations on different irrigation water quality sources invariably decreased the pH and slightly increased the electrical conductivity. In the high RSC water used, treatment with amla at 5 per cent level decreased the pH from 9.1 to 7.1 within a day after treatment and stabilized to 6.5, but EC increased from 1.8 to 1.98 and stabilized to 2.14 after a week. In all the treatments, Na and K concentrations increased leading to slight increase in electrical conductivity. The treatment of alkali (high RSC) water with amla tree dried lopping improved the quality for irrigation. ***(Key words** : RSC, EC, pH, Amla tree dried loppings, Irrigation water, quality).*

Poor quality irrigation water is a major and ever present threat to permanence of irrigated agriculture. Unless the irrigation water is of good quality, productivity decreases, land value drops, and in severe cases, the land become unproductive because of the accumulation of soluble salts especially sodium. Well water forms an important source of irrigation in Tamil Nadu. Its quality is highly variable due to climatalogical and hydrogeological conditions prevailed. Regardless of source, some soluble salts are always present in irrigation water. The nature and extent of salts however depends upon the source of water and its course before use. Since water is the chief carrier of salts, salnity control and reclamation is essential for irrigation purposes. The water intended for irrigation must be free from excess soulble or tolerable level salts and specific chemicals that may be hazardous to soil with respective salinity, sodicity, alkalinity and toxicity as the same has been recognized all over the world.

Amla, native of tropical Asia, is a deciduous medium tree with small narrow leaves arranged in two opposite rows. It has the capability of with standing even under stress conditions. The wood contains about 20 per cent tannin which on hydrolysis produces gallic and ellagic acid with a small amount of glucose. (Sinha, 1993).

The poor quality irrigation water can be successfully utilized for irrigation without any adverse effect in the soil or crop by following some agronomic management practices *viz.*, using chemical amendments, growing salt tolerant crops or dilution with good quality water or controlled irrigation. In addition to the above, there are certain experiences from the farmers that quality of irrigation water can be improved by treating it with wood cuttings of amla for which no scientific evidences are available. Hence, an attempt is made with an objective to find out the change in chemical composition on different level of alkaline water over a period of time when treated with dried lopping of amla tree.

Materials and Methods

Laboratory experiments were conducted at Anbil Dharmalingam Agricultural College and Research Institute, Tiruchirappalli during the month

of November 1997 in FRBD design with three replications. The irrigation water from the different sources *viz.*, bore well and two open wells with varying water quality and distilled water as control were treated with dried looping of amla tree, obtained from seasonal pruning for enhancing the fruit yield. Periodical water samples were drawn on 1, 3, 7 and 10 days, and analyzed for pH, EC, CO_3, HCO_3, Ca, Mg, Na and K content using standard procedures (Jackson, 1973). The laboratory data generated were subjected to statistical analysis using TNAUSTAT package and the level of significance at P=0.05 probability level was worked out for confirmation.

Results and Discussion

Initital water quality and change in pH

The chemical compositions and the pH of the different irrigation water used in the experiment are given in Table 1. The changes in pH due to treating this water with amla tree dried lopping are given in Table 2. On a day after treatment invariably, there was a significant reduction in pH levels of different irrigation waters treated with amla. Dried tree loppings of amal tree drastically reduced the pH from the initial level of 8.5, 8.9 and 9.1 in low alkaline, marginal alkaline and high alkaline water to 6.3, 6.4 and 6.5 respectively on the 10th day after treatment.

Among the different levels of wood materials added on first day, entire 5, 10 and 15 per cent levels significantly decreased the pH levels from the initial pH. On the 3rd day, the pH at 5 per cent and 10 per cent levels significantly increased and started decreaded from the 7th day. But there was no significant reduction in pH levels at 15 per cent level on the third day. Strikingly there after the pH significantly started decreasing from the 7th day and stabilized on the 10th day after treatment. Concurrently the pH at 5 and 10 per cent level decreased the pH from 9.1 to 7.1 within 24 hours after treatment and stabilized to 6.5 from 7th day. though higher levels of such wood materials lowered the pH significantly, this decrease in pH by treating with different level of wood materials over a period of time may be due to the neutrailization of CO_3 and HCO_3 by the organic acids released during the period.

Electrical conductivity

The initial and final levels EC of the different waters used in the experiment are furnished in Table 1 and 2 respectively. On the first day after treatment, consistently there was a significance increase in EC levels between different water used and among the treatment levels. In the high RSC alkaline water used, treatment with amla at 5 per cent level increased the EC from 1.80 to 1.98 with a day after treatment and stabilized at 2.14 after a week. Increase in the levels of amla wood dried lopping increased the EC levels at 5 per cent level steadily increasing the EC compared to rest levels of wood materials added. Increased in EC with increase in levels of wood materials added over a period of time may be due to the release of exudates containing different soluble salts from the wood materials.

Carbonate and bicarbonate content

The initial and final carbonate and bicarbonate contents are given in Table 1 and 3 respectively. On a day after treatment, CO_3 content decreased in all the treated alkali waters and significantly increased from 3rd day onwards upto 10th day but characteristically less than the initial level. Among the different levels of amla treated, increase in level decreased the carbonate content in all the days of sampling, and there was no significant difference in levels of amla tree dried lopping on 10th day thereby revealing that the 5 per cent level was significant to bring a drastic change in CO_3 content. The decrease in carbonate content may be due to neutralization of carbonate by the various organic acids released from the wood materials while in decay.

Table 1. Initial Composition of different samples of irrigation water

Parameters	Distilled water	Low alkaline water	Marginally alkaline water	Alkaline water
pH	6.8	8.5	8.9	9.1
EC (dSm^{-1})	0.03	1.1	1.5	1.8
Co_3 (meq/lit)	0.0	4.0	4.0	4.5
HCo_3 (meq/lit)	0.1	10.4	10.6	10.8
Ca (meq/lit)	0.0	1.8	1.4	1.3
Mg (meq/lit)	0.2	3.0	1.9	1.1
Na (meq/lit)	0.1	2.4	2.6	2.8
K (meq/lit)	0.1	0.1	0.2	0.2
SAR	1.0	1.0	1.6	2.3
RSC (meq/lit)	1.0	9.6	11.3	12.9

Table 2. Effect of amla on the pH, Electrical Conductivity and carbonate and bicarbonate content of different samples of alkali water

Treatment		Change in pH of irrigation water over period of time (in days)				Change in EC dSm^{-1} of irrigation water over period of time (in days)			
		I	II	III	IV	I	II	III	IV
Water quality	DW	7.0	7.2	7.6	7.5	0.05	0.07	0.08	0.10
	LAW	7.9	7.8	6.4	6.3	1.16	1.30	1.50	1.56
	MAW	7.6	7.8	6.5	6.4	1.62	1.70	1.96	1.94
	AW	7.1	7.6	6.5	6.5	1.98	2.06	2.15	2.14
Level (%)	Control	8.9	8.9	8.8	8.9	0.80	0.80	0.80	0.90
	0	6.5	7.2	6.6	6.5	1.80	1.90	2.00	2.10
	10	7.4	7.8	7.3	7.3	2.00	1.20	2.40	2.50
	15	8.0	7.9	7.2	7.1	2.10	2.40	2.50	2.50
(CD (P=0.05)		0.12	0.14	0.15	0.14	0.02	0.02	0.03	0.04

Table 3. Effect of amla on the carbonate and bicarbonate content of different kinds of alkali water

Treatment		Change in content over period of time (meq/litre) in days							
		I		III		VII		X	
		CO_3	HCO_3	CO_3	HCO_3	CO_3	HCO_3	CO_3	HCO_3
Water quality	DW	0.2	0.3	0.2	0.2	0.1	0.3	0.0	0.4
LAW	1.0	10.8	1.1	10.6	1.2	10.2	1.5	9.8	
MAW	1.5	10.2	1.7	9.6	1.9	9.7	2.0	8.8	
AW		2.0	9.8	1.9	10.6	2.0	10.4	2.3	8.5
Level (%)	Control	1.2	10.1	1.7	10.0	1.6	10.1	1.7	10.2
	0	1.0	8.7	1.5	8.8	1.8	9.2	1.2	7.6
	10	0.8	8.6	1.2	8.8	1.5	9.3	1.2	8.0
	15	0.9	9.0	1.0	9.3	1.6	10.0	1.0	8.4
(CD (P=0.05)	0.1	0.1	0.1	0.13	0.12	0.14	0.13	0.24	

DW - Distilled Water, MAW = Marginally Alkali Water (pH 8.6 to 9.0), LAW = Low Alkai Water (pH 8.4 to 8.6), AW - Alkali Water (Above 9.0 pH)

Similarly bicarbonate content decreased from the initial level in marginally alkaline water and alkaline water, but significantly increased in low alkalinity water within 24 hours. HCO_3 content decreased from 3rd day onwards and on 10th day, the values were significantly lesser than their initial levels notably in all the alkaline waters. Among the different levels, 5 per cent level significantly brought down the HCO_3 content from the initial level before treatment. In all the fours days of sampling, increasing amla wood level from 5 to 15 per cent increased the biocarbonate content. This may be due to the conversion of carbonate into bicarbonate, which would have contributed the increase in bicarbonate content.

Calcium and Magnesium content

The initial and final levels of calcium and magnesium are given in Table 1 and 4. Of the different alkaline water used, calcium content significantly decreased in all the periodic sampling. Increase in amla wood levels initially increased the calcium content upto the 7th day of after treatment. Significant increase in magnesium content at 5 per cent level was observed on 10th day after treatment.

Changes in sodium and potassium content

The initial and final sodium and potassium contents are given in Table 1 and 4. Treating the alkali water with amla tree dried lopping increased the sodium content with time. Of the different levels of wood materials used, no significant variation was observed among the sodium content. Treating irrigation water with amla wood materals increased the potassium content significantly from 0.1 to 1.5; 0.2 to 1.8 and 0.2 to 2.4 in low, marginal and high RSC alkaline waters respectively. Increase in wood levels increased the potassium concentration. Among the different levels, 5 per cent level of amla increased the

Table 4. Effect of amla on the cations and Residual sodium carbonate of different kinds of alkali water

Treatment	Change in content over period of time (meq/litre) (in days)								Change in content over period of time (meq/litre) (in days)								Change in content over period of time (meq/litre) (in days)			
	I		III		VII		X		I		III		VII		X		I	III	VII	X
	Ca	Mg	Ca	Mg	Ca	Mg	Ca	Mg	Na	K	Na	K	Na	K	Na	K				
Water quality DW	0.0	0.2	0.0	0.20	0.1	0.2	0.0	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.2	0.1	0.2
LAW	1.7	3.4	1.6	3.5	1.4	3.6	1,3	3.5	1.8	1.4	2.1	1.6	2.4	1.5	2.6	1.5	6.7	6.6	6.4	6.5
MAW	1.3	2.4	1.2	2.6	1.0	2.8	1.0	2.8	2.0	1.6	2.2	1.9	2.6	1.8	2.8	1.8	8.0	7.5	7.8	7.0
AW	1.0	1.6	0.9	1.8	1.0	2.6	0.9	2.7	2.4	2.0	2.5	2.2	2.8	2.4	3.0	2.4	9.2	9.8	8.8	7.2
Level (%) Control	0.1	2.0	0.1	1.9	0.1	1.9	0.1	1.9	1.8	0.1	2.7	0.1	1.8	0.4	1.8	0.2	9.2	8.8	8.7	9.9
0	1.0	2.8	1.1	3.0	1.2	3.2	1.1	3.4	1.9	1.8	1.8	1.9	2.0	2.0	2.1	2.0	5.5	6.2	6.2	4.3
10	1.2	3.2	1.4	2.8	1.3	3.0	1.3	3.2	2.0	1.9	1.9	1.9	2.0	1.8	2.2	1.9	5.0	5.8	6.0	4.7
15	1.4	3.4	1.5	3.2	1.6	3.3	1.6	3.1	2.1	2.0	2.0	2.2	2.2	2.0	2.2	2.1	5.1	5.6	6.0	4.7
(CD (P=0.05)	0.08	0.11	0.08	0.49	0.04	0.23	0.09	0.14	0.05	0.10	0.08	0.10	0.06	0.11	0.10	0.12				

potassium content with time and in the other treatment levels.

Residual Sodium Carbonate (RSC)

The initial RSC values of different irrigation water are given in Table 1 and the changes in RSC values due to treatment with amla are given in Table 5. Treating alkali water with amla tree dried wood lopping decreased the RSC values. The RSC values of low alkali water decreased from 9.6 to 6.5 meq/lit. In the case of marginally alkali water, RSC values decreased from 11.3 to 7.0 meq/lit and in high RSC water from 12.9 to 7.2 meq/lit respectively. Among the different levels of amla tree dried lopping used, compared to control, there was a drastic reduction in RSC values, but the RSC values were still higher than permissible limit of 2.5 meq/lit. However irrigation with water having RSC upto 10 meq/lit. can be safely handled continuously on sandy loam calcareous soil areas with low SAR and appreciable rainfall as reported by Gupta (1983). Thus, the appreciable reduction in RSC values of different qualities of water on application as irrigation water to the soil remarkably prolongs the process of development of soil alkalization.

From this study, it could be concluded that treatment of amla tree dried lopping at varying concentrations on different qualities of irrigation water invariably decreased the pH, CO_3, HCO_3 and Ca contents. Significant increase in Mg, Na and K content is observed after treatment with amla in all levels tried. Appreciable reduction in RSC values are noticed after treating the irrigation water with alkalinity to near safe limit with increase in the levels of amla tree dried loppings. Treatment with amla decreased the pH, CO_3 and HCO_3 contents and correspondingly the RSC values thus improving the quality for irrigation. Among the different levels of amla tree dried loppings used, 5 per cent level significantly reduced the pH, CO_3, and HCO_3 and calcium contents. In all the treatments Mg, Na and K concentrations increased after treatment with amla tree dried lopping leading to slight increase in electrical conductivity.

Thus the treatment of high RSC alkali water with 5 per cent level of amla tree dried loppings decreases the pH and RSC values remarkably and its quality for irrigation is enhanced.

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