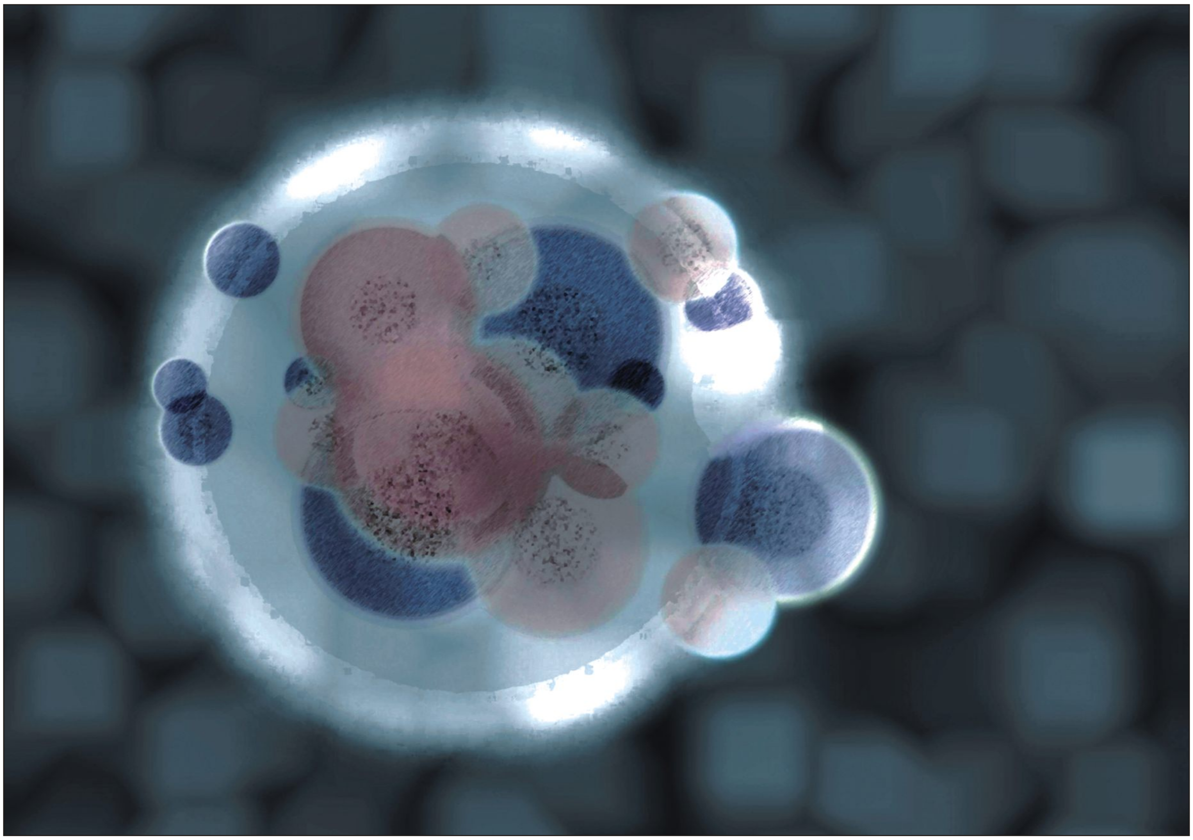

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Wheat Growth and Yield under Varying Water Qualities

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Abstract: Four various water qualities Q_1(EC =1.0 dS/m), Q_2(EC = 1.5 dS/m), Q_3(EC = 2.0 dS/m) and fresh canal water Q_4(EC = 0.4 dS/m) were used to evaluate their effects over wheat growth and yield parameters. The results showed that, irrigation with canal water Q_4 resulted significantly higher grain yield (4733.3 kg ha^{-1}) followed by Q_1 (3399.9 kg ha^{-1}). However, the lowest growth rate and yield was observed in the experimental units receiving water quality Q_2 (2116.6 kg ha^{-1}) followed by Q_3 (1333.3 kg ha^{-1}). Growth and yield contributing parameters i.e. plants per plot, plant height, spike length, seed index and grain yield found to be superior in the continuos use of canal water, followed by plots where large proportion of canal water was applied in conjugation with tubewell saline water i.e.Q_1(76%:24%), Q_2(57%:43%), Q_3(38%:62%). Thus, it is recommended that during shortage of canal water the canal and saline water could be used successfully in the proportion of 76% : 24% and 57% : 43% respectively for maximum wheat yield.

Key words: Wheat-growth-yield-water qualities

Introduction

It has been possible to raise the agricultural intensity from low level of about 60% to double by the use of conjugative irrigation of surface and groundwater. Further increase in intensity upto 150% or more is possible by proper soil and water management practices and utilization of optimum amounts of surface irrigation water and groundwater resources. The maximum use of canal water with saline water may decrease the salinity by reducing the salt concentration in soil solution, and perhaps helps in the better plant growth. It is known that due to different physiological behaviour, different crop respond differently to saline irrigation. Therefore proper management of such waters will help in maintaining the soil productivity and increased production per unit area (Ahmed and Ahmed, 1987).

Saline water exerts negative effects on plant development and crop yields. Several management practices have been developed to prevent the build-up of these effects. Integrated water, soil and crop management is necessary to overcome water quality limitations for crop production (Abdel Dayem and Hamdy, 1994). Appropriate water quality applications would be possible, if, soil and water management practices would be improved, and adequate water for leaching the salts would be available. Water quality of tubewells has deteriorated with time due to upcoming population and production pressures. Re-use of tubewell drainage effluent is mobilizing 2.4-5 tons salt ha^{-1} per year, and part of which is being retained by the soil. Nearly, 2.4 Gm^3 of saline effluent from surface and subsurface drainage systems is currently being disposed into the canals (46%) and rivers (54%) and the same water is used for irrigation at the downstream of the system. This seems an efficient use of a scarce resource but is not without risks due to mismanagement.This is possible only by controlling the dilution ratio below the detrimental effects on soils and crops (Bhutta *et al*., 1996). The research study conducted at LIM during 1994, on non-saline, non-sodic, loam to silt loam soils; and it was reported that water with EC less than 1500 μS/m is safe for irrigation, waters having electrical conductivity between 1500 to 3000 μS/m requires mixing of canal water before use for irrigation purpose, and waters with electrical conductivity exceeding 3000 uS/m require correspondingly higher dilution with canal water and can only be used to irrigate salt-tolerant crops. Minhas (1996) reported that high salinity during the initial stages of growth is particularly harmful. Further, if benefits are to be gained from frequent saline irrigations, the amount of water applied per irrigation needs to be reduced in conjunction with fresh canal water during pre-sowing irrigation period. Saline drainage water (EC = 16-18 dS/m) with good quality canal water (EC = 0.5 dS/m) for irrigating wheat crop can be used without any soil degradation, but, saline drainage water of 9 dS/m can safely be used for irrigation of wheat in sandy loam soils when a subsurface drainage system is available. The wheat yield response to varying water qualities showed that the threshold response was at 3.82 dS/m. No cumulative salt build-up was observed over the 3-year study period and fluctuations in soil salinity were within crop tolerable limits (Kumbhare *et al*., 1996). This study is a step in the right direction to develop technology for use of poor quality waters in relation to wheat crop.

Materials and Methods

The field experiment was laid-down at Sindh Agriculture University, Tandojam. The soils at the site were classified as clay loam. The experiment was set with four treatments each replicated four times in a Randomized Complete Block Design (RCBD). The treatments consisted of application of water having different ECe (dS/m) values i.e. Q_1 = (EC = 1.0 dS/m), Q_2 = (EC = 1.5 dS/m), Q_3 = (EC = 2.0 dS/m) and canal water Q_4 = (EC = 0.4 dS/m).

Cultural and management practices: The experimental area was prepared by cross plowing with a disk harrow followed by leveling. The seeds of Sarsabz wheat variety were drilled with hand drill. Fertilizers at the rate of 137-67 N-P $kgha^{-1}$ were incorporated, full dose of P_2O_5 and 1/3 dose of N was applied at final harrowing, however remaining dose of N was incorporated in two splits i.e. at the time of vegetative stage (maximum tillering) and 2nd at the time of booting stage.

Preparation of desired Water quality (Treatments): The desired quality of water for irrigation was prepared by mixing the canal water (ECe = 0.40 dS/m) with poor quality tubewell water (ECe = 3.0 dS/m). The preparation of desired water qualities used in this experiment were as follows:

Q_1 = EC = 1.0 dS/m

This particular water quality was prepared by mixing the tubewell water with canal water until it reached the desired EC of 1.0 dS/m. The percentage distribution of the proportion of tubewell and canal water used, (in order to reach the desired EC), was computed using:

Desired EC_w = [EC_w (T.W) . a] + [EC_w (C.W) . b] ------------ (1)

Where,

EC_w (T.W) = Electrical conductivity of tubewell water (dS/m)

EC_w (C.W) = Electrical conductivity of canal water (dS/m)

a = Proportion of tubewell water to be used

b = Proportion of canal water to be used

Let, EC_w (T.W) = 3.0 dS/m,
EC_w (C.W) = 0.40 dS/m,
and desired EC (blended water) = 1.0 dS/m

Substituting these values in the above equation and solving for a and b we get:

$1.0 = 3.0 \times a + 0.40 \times b$ ------------------------- (2)

Using the equation: $a + b = 1$ OR $a = 1 - b$
By putting the value of a in equation-(2):

$1 = 3 \times (1-b) + 0.40 \times b$ OR $b = 2/2.6 = 0.76 = 76\%$
b = 76% (Proportion of canal water used) and
a = 24% (Proportion of tube water used)

Q_2 = EC = 1.5 dS/m.
Computing the percentage distribution of canal and tubewell water used in this water quality yielded b = 57% (Proportion of canal water used) and, a = 43% (Proportion of tubewell water used).

Q_3 = EC = 2.0 dS/m

The required mixing ratio computed was, b = 38% and a = 62%.

Q_4 = Canal waters having EC = 0.40 dS/m

These water qualities were prepared in the field before irrigation application. Plastic drums of various sizes were used for mixing and, the mixing ratio was maintained on volumetric basis.

Water supply management: To apply desired quality waters in the treatment plots, a siphon was used to divert the water from plastic drums to the plots. A uniform doze (depth) was applied under each treatment.

Results and Discussion

Four water qualities i.e. Q_1 (EC = 1.0 dS/m), Q_2 (EC = 1.5 dS/m), Q_3 (EC = 2.0 dS/m), Q_4 (Canal Water EC = 0.4 dS/m) under saline-water management practices applied to determine their effects on growth and yield of wheat crop. The proportion of both the canal and tubewell water used for preparation of desired water qualities were Q_1 (76% : 24%), Q_2 (57% : 43%), and Q_3 (38% : 62%). However, 100% canal water was applied under treatment Q_4.

Water analysis: The pre-project analysis of canal and tubewell waters used in this study was EC = 0.4 and 3.0 dS/m, pH = 7.4 and 8.3, SAR = 0.9 and 7.32, respectively (Table 1). According to Gupta (1952), the water having EC$\geq$3.0 dS/m classified as poor quality saline water. The use of such water quality effectively enhance the soil and crop parameters.

Grain yield (Kg ha^{-1}): The maximum mean grain yield 4733.3 Kg ha^{-1} was observed from the treatment Q_4 (EC = 0.4 dS/m) where canal water was applied throughout the growth period, while minimum mean yield per hectare i.e. 1333.3 kg ha^{-1}, 2116.6 kg ha^{-1} and 3399.9 kg ha^{-1} were found from the treatments receiving the water qualities Q_3 (EC = 2.0 dS/m), Q_2 (EC = 1.5 dS/m) and Q_1 (EC = 1.0 dS/m) respectively. The findings are in agreement with Kumar (1979), Ansari *et al.* (1978), Tripathi and Pal (1980) and Bijendra and Narian (1980) who reported that grain and straw yield were significantly decreased with the application of saline water. Also Kanwar and Kanwar (1969) reported that yields of wheat decreased as the salt concentration increased (Table 2).

Conclusion and Recommendations: The soil salinity due to application of saline water in large proportion decreased crop growth and yield parameters significantly. However, tubewell saline water and large combination of canal water, or application of canal water throughout wheat growing season exhibited highest values of crop parameters. Thus, it is recommended that use of canal water is better approach to obtain higher yield by improving the soil condition towards

Table 1: Chemical analysis of canal and tubewell water

Kind of water	EC (dS/m)	pH	Anions (Meq/L)				Cations (Meq/L)		SAR
			CO_3	HCO_3	CL_2	SO_4	Ca+Mg	Na	
Canal	0.40	7.4	Nil	1.4	1.2	1.8	2.03	1.01	0.9
Tubewell	3.00	8.3	Nil	6.0	20.0	17.2	20.0	23.15	7.3

Table 2: Plant characters as affected by different water qualities

Water Qualites (Q)	Plants per plot	Plant height (cm)	Spike length (cm)	Seed Index (100 Grain Weight) (gm)	Grain Yield (Kg ha^{-1})
Q_1	520 b	83.82 ab	16.95 ab	3.46 b	3399.9 b
Q_2	431 c	76.82 b	15.20 b	2.66 c	2116.6 c
Q_3	360 d	51.38 c	10.32 c	2.27 c	1333.3 d
Q_4	635 a	94.65 a	19.52 a	4.18 a	4733.3 a
LSD =	30.8	13.09	3.46	0.676	752.3

Q_1 = (EC = 1.0 dS/m) Q_2 = (EC = 1.5 dS/m) Q_3 = (EC = 2.0 dS/m) Q_4 = (Canal Water EC=0.4 dS/m) productivity. But, if the availability is scare, tubewell saline water can be used in conjunction with canal water with a suitable mixing ratio having large proportion of canal water and small proportion of saline water to avoid excess accumulation of salts in the root zone and achieving better yields.

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