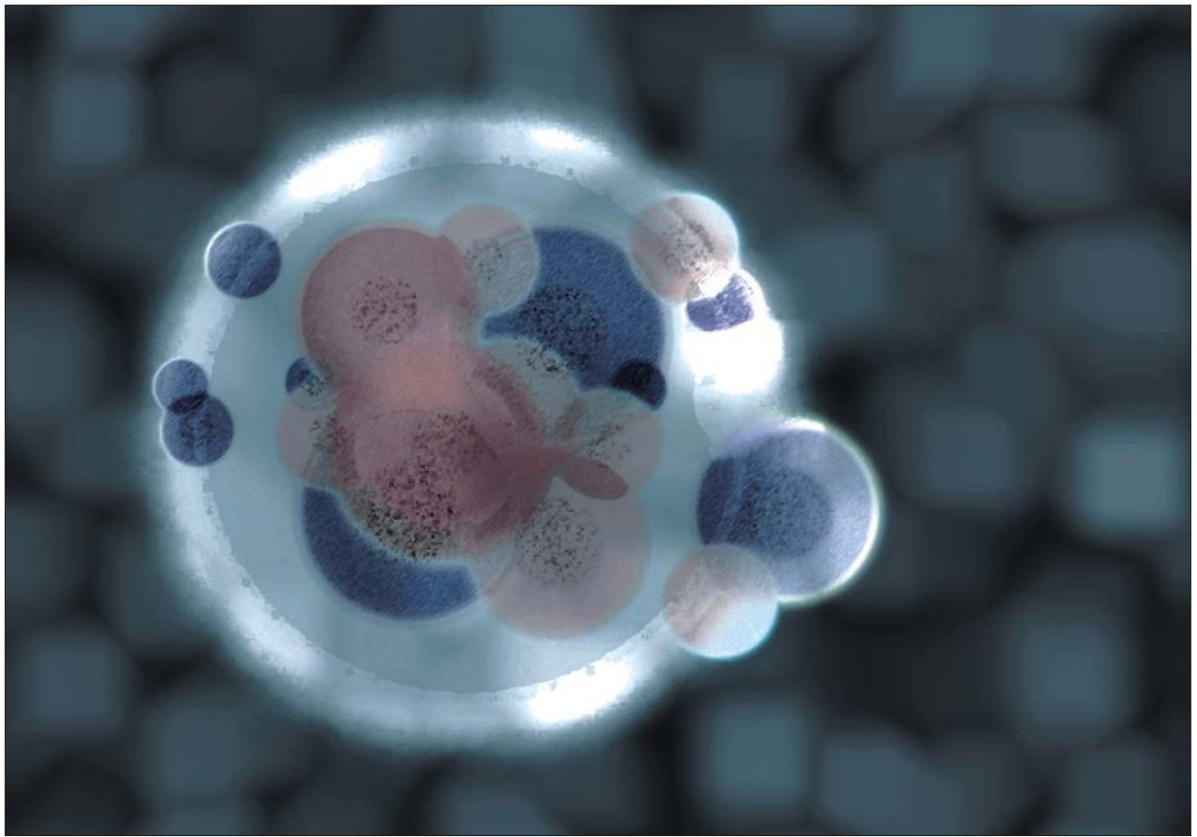




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Effect of Irrigation Intervals on Soil Salinity and Cotton Yield

A. Soomro, M.S. Mirjat, F.C. Oad, H. Soomro, M.A. Samo and N.L. Oad
Sindh Agriculture University, Tando Jam, Pakistan

Abstract: The effect of irrigation intervals on seed cotton yield at 14 days interval resulted significantly greater cotton yield as compared to 7 and 21 days intervals. The increase in yield was associated to significant increase in branches, total number of productive bolls and yield per plant. The chemical analysis of soil showed little increase in soil pH values, however, decreasing trend in EC_e, ESP and SAR was noted in the samples collected after harvest as compared to those collected before sowing.

Key words: Cotton, irrigation intervals, yield, saline soil

Introduction

Soil salinity is the universal problem and it is increasing with the passage of time both in humid and semi-arid regions. The growers of these regions are experiencing the problem of salt accumulation. In semi arid regions the problem is related to shortage of water, whereas, in humid regions it is due to excess water which causes rise in water tables by resulting upward movement of salts (Rashid, 1994). Pakistan is not exception to this problem, nearly one fourth of the total irrigated land is reported as saline (International Irrigation Management Institute, 1997) and nearly 60% of this area is sodic in nature (Hassan *et al.*, 1975). However, the reports of National Commission on Agriculture (1987) indicates over 23% of the salt affected area falls within canal commands of the country. In the areas with water shortage, brackish ground water is being used after mixing with the canal water. Bhatti (1986) and Lower Indus Water Management Research Project (1994) studied that application of such water does not reduce significantly the crop yields, but in long run salts may accumulate in the soil profile. As pointed by Siyag *et al.* (1995), the use of saline water with EC over 4.8 dS/m causes an appreciable salinity build up in the soil profile. However, soil salinity changes with the application of irrigation. Since more frequent irrigation maintains better water availability in the active root zone that result in dilution of salts which are then leached down, which ultimately optimize the crop production. The method of irrigation has significant effect on salt accumulation in the soil (FAO, 1980). The under irrigation results in accumulation of salts in the root zone. In contrast, over irrigation increases the ground water levels that cause upward movement of salts (Rashid, 1994). However, frequent application of irrigation leaches the salts from the rootzone and provides better environment for crop growth. Sometimes soil salinity develops inspite of good quality irrigation water and good irrigation practices (Michael, 1978). It is due to improper drainage, soil and cultural practices and unsuitable cropping pattern. Since, the high concentrations of salts act adversely on the physical, chemical, and biological properties of the soil. The accumulation of salts usually takes place during the germination up to harvesting period in the crop root zone which results in less economic productivity of crop. No proper guidance is being provided to the farmers as to when a crop should be irrigated and how much water should be applied to optimize production. This causes under or over irrigation and leads to the development of salinity and waterlogging problems. Thus, better irrigation management practices are required that would reduce soil salinity and produce high crop yields. Several studies have been conducted in this regard. In a study, Bordovsky *et al.* (1992) reported

that it is not necessary to get high yields with high amount of water, their results show reduction in lint yield with increased amounts of irrigation. Soliman *et al.* (1976) reported that soil salinity as well as irrigation intervals significantly affected flowering and cotton yield. Keeping in view the above varying facts an attempt has been made to determine the effect of different irrigation intervals on cotton yield, as well as on salinity status. This would help farmers to adopt a suitable irrigation interval for maximum and sustainable production under saline conditions.

Materials and Methods

A field trial was conducted at the experimental field of Drainage Research Center, Tando Jam during 1997 to determine the effect of different irrigation intervals on the yield and salinity status of soil. Three irrigation interval treatments consisted of 7, 14, 21 days, each replicated four times in the setup of Randomized Complete Block Design. The soil at the site classified as medium textured, having bulk density of 1.4 g/cm³, moisture retaining capacity up to 27% and water table located at a depth of about three meters. A uniform soaking dose of 10 cm was applied for seedbed preparation and subsequent irrigations were applied on the basis of moisture depleted between irrigations and rooting depths. Cotton variety Niab-78 was sown on May 15, 1997 in rows of 75 cm apart with a plant spacing of 22.5 cm, in plots measuring 23.50 × 6.75 m². A basal fertilizer dose of 125-56 kg NP/ha was applied in the form of Urea and DAP, the full dose of P with half dose of nitrogen was applied at the time of sowing, while, the remaining N was split and top dressed at flowering and boll formation stages. All the cultural practices such as; ploughing, seedbed preparation, sowing, weeding, earthing, and pesticide application etc. were adopted as required. The irrigation interval treatments began after first irrigation that was applied after 30 days of sowing. The amount of water required for each irrigation was based on the moisture depleted between irrigation and rooting depth of crop. The depth required to irrigate the crop was calculated using equation given by Hansen *et al.* (1980).

$$D = \frac{(SMD)p_b d_r}{\gamma_{w100}}$$

Where,

D = depth of water required (cm)
SMD = soil moisture deficit (%)

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Table 1: Data on different plant growth and yield parameters as affected by different irrigation treatments

Crop parameters	Irrigation Interval Treatment			Probability level	
	7 days	14 days	21 days	LSD (5%)	LSD (1%)
Plant growth rate (cm/day) during full growing season	0.61b	0.70a	0.56c	0.04	0.08
Number of sympodial branches per plant	28.0b	29.0a	26.0c	0.59	0.78
Total number of productive bolls/plant	25.0b	30.0a	21.0c	1.04	1.57
Yield per plant (g)	68.8b	82.4a	66.2c	1.35	2.05
Yield (kg ha ⁻¹)	1418.0b	2516.0a	1224.0c	131.15	198.83

Means sharing same letters in a row do not differ significantly at $p < 0.05\%$ level

Table 2: Soil pH, ECe (dS/m), ESP and SAR observed before sowing and after harvest (7, 14, 21- days irrigation intervals)

Irrigation Interval (days)	Sampling depth (cm)				
	0-15	15-30	30-60	60-90	90-120
Soil pH					
Before sowing	7.2	7.4	7.3	7.3	7.4
After harvesting					
7	7.6	7.8	7.8	7.9	7.8
14	7.8	7.7	7.8	7.7	7.7
21	7.7	7.7	7.8	7.7	7.7
ECe					
Before sowing	3.1	3.9	4.1	3.6	3.8
After harvesting					
7	2.4	2.3	3.5	2.7	2.6
14	2.1	3.7	4.4	4.0	3.9
21	2.5	4.1	4.0	3.6	3.7
ESP					
Before sowing	1.9	2.2	3.8	2.4	2.7
After harvesting					
7	1.5	1.7	3.6	2.1	1.6
14	1.5	1.9	3.5	2.9	2.0
21	1.9	1.6	2.1	2.8	2.4
SAR					
Before sowing	2.2	2.4	3.6	2.5	2.7
After harvesting					
7	1.9	1.1	2.0	1.6	1.9
14	1.9	1.2	2.9	1.7	1.7
21	1.9	1.1	2.5	1.4	1.7

ρ_b = bulk density (g/cm³)

γ_w = specific weight of water (g/cm³)

d_r = root depth (cm)

$$SMD = \Theta_i - \Theta_o$$

Where,

Θ_i = Soil moisture at field capacity (%)

Θ_o = Soil moisture at the time of irrigation (%)

Soil moisture was determined by oven drying the soil for 24 hours at a temperature of 105°C and was calculated by appropriate equation. Every time the identified quantity of irrigation was applied to each treatment as per its requirement and flow was measured by cutthroat flume (90 × 10 cm size) installed in the middle of water channel.

To assess the soil salinity under irrigation treatments, composite soil samples were collected before sowing and after harvesting for pH, ECe, SAR, ESP. Soil pH was determined by pH meter, EC meter measured EC, while ESP and SAR were calculated using appropriate formulae.

Results and Discussion

The experimental results for yield and its related components showed significant effects of different irrigation intervals. The irrigation applied at 14 days interval had the highest plant growth rate compared to 7 and 21 days irrigation intervals (Table 1). Similar trends were observed for number of sympodial branches, and bolls per plant. Ultimately, due to high growth rate, the plants were healthy and taller under 14 days treatment and produced more sympodial branches and bolls per plant that resulted in higher seed cotton yield per plant.

The increase in cotton yield under 14 days interval, attributed to significant increase in number of branches/plant, number of productive bolls/plant, and seed cotton weight/plant, which in turn caused maximum yield. Earlier research by Baluch (1974), Saunders and Gill (1980) has reported that the usual interval for irrigating cotton crop is between 15-21 days depending on soil type and climate. This demonstrates that greater irrigation interval reduces cotton yield.

The soil chemical properties such as, pH, ECe, SAR, and ESP were determined before sowing and after harvesting to observe change in soil salinity status. The data showed an increase in soil pH values observed at various depths under all treatments, but it did not show any significant difference between irrigation treatments. These trends revealed that the irrigation interval treatments had no effect on increase of soil pH but it might be due to chemical reaction of soluble salts present in the soil (Table 2). Though, the results indicated an increase in soil pH but it is still in the safe limits and is not harmful for crop. It was further noted that pH and ECe did not vary between the irrigation treatments while exchangeable sodium percentage (ESP) and Sodium adsorption ratio (SAR) varied between the irrigation treatments. Sodium adsorption ratio decreased after harvest, it demonstrates that irrigation water might have leached the sodium toward deeper depths. So it is concluded that maximum cotton yield could be achieved with 14 days interval as compared to longer interval (21 days) and shorter interval (7 days). Irrigation at the adequate rate when applied to cotton sown in saline soil reduces soil ESP and SAR that can give more benefit to shallow rooted crops such as, wheat or brassica etc. that are grown after cotton. For the better crop growth and maximum yield, 14-days interval treatment is recommended for the surrounding area as well as the areas with similar soil and climatic conditions.

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