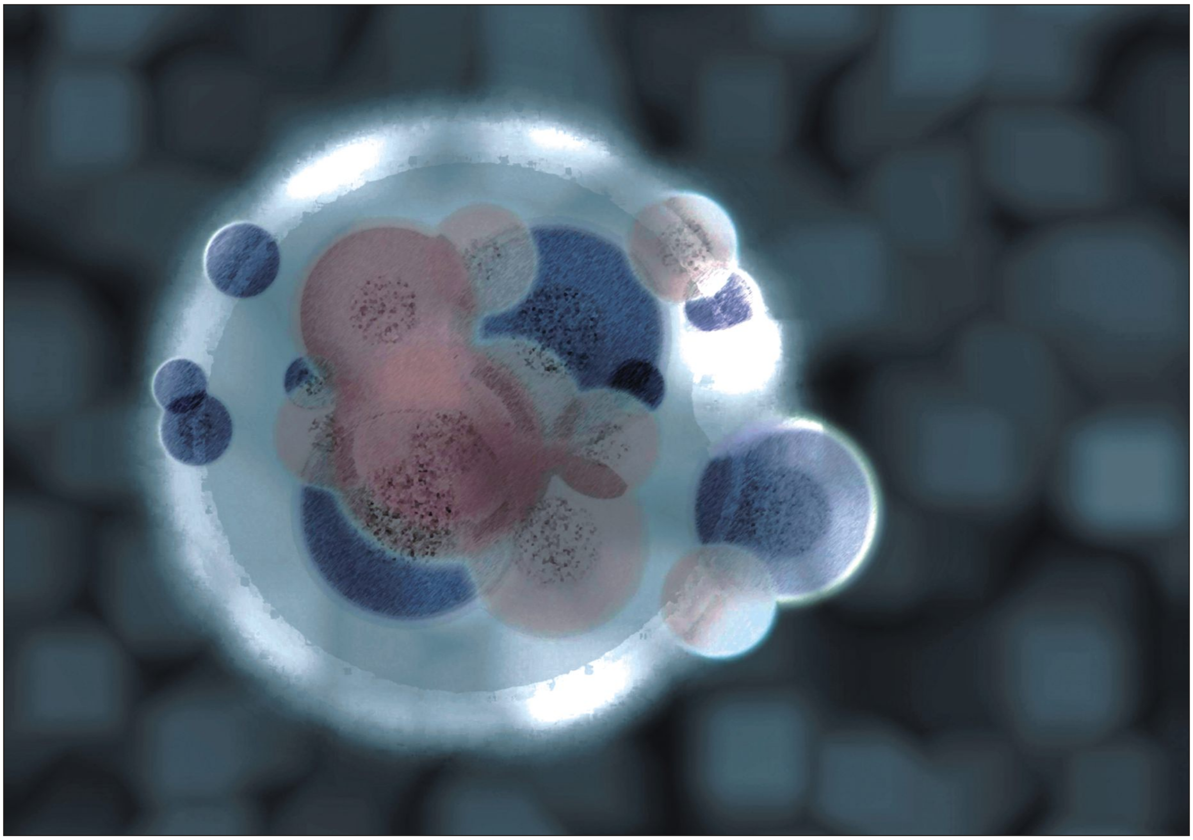

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Yield and Water Use Efficiency of Sunflower Crop under Moisture Depletions and Bed Shapes in Saline Soil

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Abstract: The textural class of soil was identified as clay loam and silty clay at 15-90 cm and 0-30 cm soil depths respectively. The chemical analysis of the soil showed ECe = 4.43 dS/m, pH = 8.20, SAR = 8.33 and ESP = 9.93. The planting of sunflower H0-1 was done on V-shaped furrows and flat beds; tested under varying moisture depletions. The maximum and satisfactory seed yield (2560 kg ha^{-1}) was observed in the V-shaped furrows irrigated at 50% soil moisture depletion (SMD) followed by 70% SMD. However, excess water at the level of 30% SMD and stress conditions (90% SMD) exhibited very low yields. Water use efficiency (85.41 kg ha^{-1} cm^{-1}) was also high in V-shaped furrow beds irrigated at 50% SMD. Thus, for saline soils it is recommended that sunflower must be planted on furrows and water should be applied at the rate of 50% soil moisture depletion level (SMD) for maximum water use efficiency and satisfactory sunflower seed yields.

Key words: Sunflower, water depletion, water use efficiency, yield, saline soil

Introduction

Water is essential for crop production and the best use of available water must be made for efficient crop production and higher yields. Irrigation is most important in areas where climatic conditions are unfavorable, water, land resources are limited, and rainfall is scanty and sporadic. Therefore, agriculture under such conditions can not be profitably practiced thus, farm water management in these areas must be improved to meet the present growing demands for increased food production. This requires a proper understanding of the effect of rainfall and irrigation on crop growth and yield under different growing conditions. In order to conserve water, emphasis should be given to it's efficient use. The principal factor in ensuring successful agriculture on saline soil, are crop and soil management practices and selection of correct method of irrigation should be such that there should be neither under-irrigation nor over-irrigation.

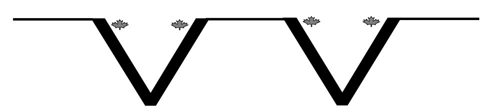
Soil salinity and sodicity is of common occurrence in arid and semi-arid region where irrigated agriculture has been practiced. About 23% of presently cultivated land in the world is affected by salinity and sodicity (Tyagi, 1996). Salinity is assumed to manage with depth to the bottom of rootzone. The average salt concentration of the soil solution in the rootzone is assumed to be three times the salinity of the applied water. This average is assumed to be the salinity to which the crop responds. The salinity and sodicity above tolerance level adversely affect physical and chemical characteristics, yield, and its indirect effect in increasing uptake of Na^+ and decreasing uptake of K^+. The roots also are less able to exclude Na^+, even in presence of improved soil physical conditions (Wright and Rajpar, 2000). Further, the sowing practices in saline soil must in a way that concentration of the salts should be changed in diluted form to withstand the crop (Oad *et al*., 1996). Decreasing irrigation water is not a strategy but the optimum use of water is best known by the researcher. The high population density and the need to develop national economics have resulted in a high demand to intensity land and water use for the purpose of increasing and stabilizing agricultural production (Matar, 1999). The needs are very acute in the country where the water requirements of crops are greatest while the supplies are least, thus, it resulted in a sharp decline in available water for irrigation purpose in its quantity and quality (Al-Jamal *et al*., 1997). So tenuous and dislocate is the water economy of most crops that even short term deprivation can cause sufficient stress to impair normal physiological functions and potential yield (Rhoades *et al*., 1992). This study also aims to identify adequate water need of the crop under varying moisture depletions and planting practices for saline soils to obtain maximum yield production and water conservation.

Materials and Methods

The field experiment was conducted in saline soils of Khesana Mori, 3 Km away from Sindh Agriculture University Tando Jam, during 1999. The experimental treatments were laid-down in RCBD, replicated thricely in net plot size of 3 m × 7.9 m to test moisture depletions (30, 50, 70 and 90% depletions on available soil moisture (SMD) under two bed shape of planting (B_1 = Flat bed and B_2 = V-shaped furrow).

Cultural practices

Bed shape: The furrows and ridges at the height of 2' and 2' apart were prepared and planting was be done on the ridges as it look V-shape. However, in flat bed the soil was well leveled.



Design and planting in V-shape Furrow bed

Identifying soil moisture depletions: It involves determining the current water content of the soil. The Gravimetric sampling method was used.

Moisture content (%) on dry weight basis:

$$\Theta_w \quad \frac{Ww - Wd}{Wd} \times 100 \qquad \text{----------- (1)}$$

Where,
Θ_w = Moisture content on dry weight basis (%)
Ww = Wet weight of soil (g)
Wd = Oven dry weight of soil (g)

How much to irrigate

$$D = \left(\frac{FC - SMC}{100}\right) \times As \times dr \qquad \text{----------- (2)}$$

Where,
D = Depth of water to be applied (cm)
FC = Field capacity (%)
SMC = Soil moisture content before irrigation (%)

Table 1: Yield and field water use efficiency of sunflower crop in saline soil

Bed shape	Moisture Depletion levels (%)	Water consumed (cm)	Yield ($kg\ ha^{-1}$)	Field water use efficiency ($kg\ ha^{-1}\ cm^{-1}$)
Flad Bed	30	33.02	650.00	20.38
	50	29.97	1010.00	33.70
	70	29.97	1020.00	34.03
	90	22.35	440.00	19.68
V-shape furrow bed	30	33.02	850.00	25.74
	50	29.97	2560.00	85.41
	70	29.97	1550.00	51.71
	90	22.35	650.00	29.00

Table 2: Irrigation schedules for diffrent depletion levels using moisture content as a soil indicator to consume water

No. of irrigation	Soil moisture depletion level							
	F (day)	D (cm)	F(day)	D(cm)	F(day)	D(cm)	F(day)	D(cm)
Soaking dose								
1	25	7.62	25	7.62	25	7.62	25	7.62
2	8	3.81	15	7.11	23	10.16	35	14.46
3	8	4.31	15	7.87	23	12.19		
4	8	4.82	15	3.36				
5	7	4.31						
6	6	3.81						
7	8	4.31						

As = Apparent specific gravity of soil (1.25)
dr = Depth of rootzone (cm)

How long to irrigate: It involves cut-throat flume for discharge flow, fixed in the middle of channel.

$$Qt = a.d \text{ ------------------------------ } (3)$$

Where,
Q = discharge (m^3/sec)
t = Time (Sec.)
a = Area (hectare)
d = Depth of applied water (m)

Results and Discussion

The textural class of soil was identified as clay loam at the soil depth of 15-90 cm and silty clay at 0-30 cm. Soil chemical analysis showed ECe = 4.43 dS/m, pH = 8.20, SAR = 8.33 and ESP = 9.93 and marked as saline soil.

Yield: Yield of sunflower as affected by bed shape planting and water depletions showed significant differences among the tested factors. Sunflower seed yield was exhibited maximum (2560.00 Kg ha^{-1}) in the plots which received 50% SMD followed by 70% SMD which recorded (1550.00 Kg ha^{-1}). The adverse effect of excess irrigation (7 irrigation frequencies) and stress conditions (2 irrigation frequencies) under 30 and 90% SMD respectively was observed where sunflower seed yield declined.
Bed shapes showed significant differences in the numerical values for seed yield. Maximum seed yield was recorded in V-shaped furrows. Thus, it was proved that furrow planting was efficient one (Table 1).
The interaction of bed shape and SMD showed best combination of V-shaped furrow planting and 50% SMD where satisfactory seed yield was noted however, stressed plots (90% SMD) of flat bed found to be less efficient in producing seed yield.

Field water use efficiency: Field water use efficiency of 85.41 kg ha^{-1} cm^{-1} was recorded highest in furrow bed at 50% SMD, followed by 51.71 kg ha^{-1} cm^{-1} at 70% SMD, whereas lowest water use efficiency was recorded 19.68 kg ha^{-1} cm^{-1} in flat bed at 90% SMD (Table 1).

Irrigation Scheduling: Irrigation schedules were designed on the basis of soil moisture depletion levels i.e. 30, 50, 70 and 90%. Discharge was measured by Cutthroat flume and the required depth of water was calculated using the equation-3, to satisfy soil moisture at field capacity level. The eight irrigation levels were applied in 30% SMD. Plots which received 50, 70 and 90% SMD they recorded 4,3, and 2 irrigation frequencies respectively. Thus, it is recommended that sunflower crop in saline soils should be planted on furrows and irrigation must be applied at 50% soil moisture depletion for obtaining maximum water use efficiency and higher yields (Table 2).

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