WATER USE EFFICIENCY OF DIFFERENT PLANTING METHODS IN COTTON (*GOSSYPIUM HIRSUTUM* L.)*

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ABSTRACT

Water use efficiency in different planting methods of cotton (*Gossypium hirsutum* L.) was evaluated at three locations in cotton zone of Punjab, Pakistan during the year 2004. Six planting methods viz. flat planting and no earthing up (P_1), flat planting and earthing up after 1st irrigation (P_2), flat planting and alternate row earthing up after 1st irrigation (P_3), flat planting in 112.5/37.5 cm apart paired rows and earthing up after 1st irrigation (P_4), ridge planting (P_5) and bed planting (P_6). Cotton crop obtained maximum benefit from available water at all three locations in P_3 (flat planting with alternate row earthing up) predicting maximum water use efficiency (6.79 kg/ha/mm) with higher seed cotton yield (3432.50 kg/ha).

KEYWORDS: *Gossypium hirsutum;* ridging; seedbed preparation; water requirements; Pakistan.

INTRODUCTION

Pakistan is predominantly an agricultural country and prosperity of people depends largely upon the successful cultivation of crops like wheat, cotton, rice, sugarcane and maize. Among these, cotton occupies central position because of its substantial foreign exchange earnings (76%) through export of raw cotton, yarn and finished products (1). In addition, cotton crop also provides livelihood to millions of people, who are engaged in textile industry directly or indirectly.

Realizing role of this crop in building the economy of Pakistan, its yield improvement has always been the objective of extensive research under local environmental conditions and better utilization of sources available for successful crop production. Successful cotton production totally depends upon the availability of irrigation water either from canal or tubewell. Irrigated agriculture is facing acute competition for low cost and high quality water (7). High quality irrigation water is becoming another challenge and the world is looking for water saving agriculture, which refers to full advantage of available irrigation facilities (12). Water saving agriculture intends to raise water utilization rate and efficiency for achieving a high economic yield on irrigated farm land with minimum input of water at both public and private levels.

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Water use efficiency (WUE) is a potential selection criterion for improving yield under water stress and it evaluates the way and depth of water application, whether it was used at optimum level by the crop. Usually cotton crop uses less water per hectare than other crops with exception of horticulture (5). WUE is not simply a water saving irrigation but it is a comprehensive exercise using every possible water saving measures in farm production, including full use of natural precipitation as well as efficient management of an irrigation network through a suitable planting method. Planting methods are important factor which affects crop growth development and finally the crop yield. Decrease in row spacing increased light interception, growth rate, total biomass production and water use efficiency (9). Better irrigation water use efficiency can be achieved through adopting the best management practices of irrigation (4). According to McAlavy (8) adoption of subsurface irrigation on smaller acreage can increase cotton yield, water use efficiency and return per acre.

Adoption of appropriate planting method and water management for successful crop production are the most critical problems especially in cotton growing areas of Pakistan. The underground water is almost brackish and canal water, the only source, is becoming scarce day by day which necessitates to utilize every inch of available water efficiently.

WUE of a crop is an important consideration where irrigation water resources are limited or diminishing and rainfall is a limiting factor. Additionally, recent increases in energy prices have attracted attention of crop producers asking how to manage inputs to maximize efficiency of their water resources. Regardless of the situation, it is crucial that growers have to get optimum out of every inch of available water, whether it comes through irrigation, rainfall or both.

No systematic work was done in the past to evaluate various sowing/planting methods for water saving and to increase water use efficiency. A contradiction exists for water saving by newly adopted bed/ridge sowing method and flat sowing.

The present study was undertaken to find out the most suitable method of planting cotton crop to save water as well as to increase WUE for improving seed cotton yield per unit of land.

MATERIALS AND METHODS

This study was conducted during the year 2004 at three locations i.e. Agronomic Research Station, Bahawalpur, Farmer's field in district

Bahawalnagar and Farmer's field at Ahmed Pur East. Two cotton varieties (BH-160 and CIM-506) were planted in 2nd fortnight of May under six different planting methods viz. flat planting and no earthing up (P_1), flat planting and each row earthing up after 1st irrigation (P_2), flat planting and alternate row earthing up after 1st irrigation (P_3), flat planting in 112.5/37.5 cm apart paired rows and each row earthing up after 1st irrigation (P_4), ridge planting (P_5) and bed planting (P_6). The trial was laid out in split plot arrangement giving more importance to planting methods. Plot size was 4.5 x 15 meter. First irrigation was applied to P_1, P_2, P_3 and P_4 at 35 days after planting and earthing up was done according to the treatments. P_5 and P_6 were irrigated just after planting. Afterwards subsequent irrigations were applied according to the need of crop and planting methods. Each time a measured quantity of irrigation water was applied with the help of cut throat flume using formula *Qt = Ad or t = Ad/Q* and each irrigation was 7.5 cm in depth. Data were recorded and water use efficiency was calculated according to Viets formula (11).

$$WUE = \frac{\text{Crop yield (economic yield)}}{\text{Water used to produce the yield}}$$

Seed cotton yield data were analyzed statistically by using Fisher's analysis of variance techniques and least significant difference (LSD) at 5 percent probability was applied to compare the differences among treatment means (10).

RESULTS AND DISCUSSION

The data (Table) revealed that crop obtained maximum benefit from water available in flat planting with alternate row earthing up (P_3) at all three locations. At location-1 maximum water use efficiency (6.79 kg/ha/mm) was recorded with maximum seed cotton yield (3432.50 kg/ha) followed by paired row planting(P_4) (6.34) and flat planting with each row earthing up(P_2) (5.49) with seed cotton yield of 3355.50 and 3421 kg per hectare, respectively.

Similar trend was observed at location 2 and 3. Maximum water use efficiency (5.13 and 6.34 kg/ha/mm) was obtained from flat planting with alternate row earthing up(P_3) with higher seed cotton yield of 2655.50 and 3325 kg per hectare at location-2 and 3, respectively. It was most probably due to better utilization of available water by crop plants in P_3. Flat planting and no earthing up (P_1) accompanied by ridge planting method (P_5) were statistically at the lowest position in water use efficiency at all locations. These findings are in consonance with those of earlier workers (3, 4, 5, 6, 7)

while some others (8, 12) report that crop water use efficiency can be enhanced by sprinkler or drip irrigation systems.

Table. Water use efficiency and seed cotton yield in different planting methods.

Planting methods	Seed cotton yield (kg/ha)	Total water used (I+R)* (mm)	Water use efficiency (kg/ha/mm)
Location – 1			
P_1 = Flat planting and no earthing up	3173.00 b	636	4.98 c
P_2 = Flat plating and each row earthing up after 1st irrigation	3421.00 a	623	5.49 b
P_3 = Flat planting and alternate row earthing up after 1st irrigation	3432.50 a	506	6.79 a
P_4 = Flat planting in 112.3/37.5 cm apart paired rows and each row earthing up after 1st irrigation	3355.50 a	529	6.34 a
P_5 = Ridge planting	3149.00 b	638	4.94 c
P_6 = Bed planting	3175.00 b	538	5.30 b
LSD value	84.89	-	0.50
Location – 2			
P_1 = Flat plating and no earthing up	2569.00 d	664	3.87 b
P_2 = Flat plating and each row earthing up after 1st irrigation	2639.50 b	642	4.12 b
P_3 = Flat planting and alternate row earthing up after 1st irrigation	2655.50 a	518	5.13 a
P_4 = Flat planting in 112.3/37.5 cm apart paired rows and each row earthing up after 1st irrigation	2609.00 c	546	4.78 a
P_5 = Ridge planting	2538.00 e	652	3.90 b
P_6 = Bed planting	2498.50 f	604	4.14 b
LSD value	5.88	-	0.63
Location – 3			
P_1 = Flat plating and no earthing up	3162.50 d	673	4.70 c
P_2 = Flat plating and each row earthing up after 1st irrigation	3312.50 c	649	5.11 bc
P_3 = Flat planting and alternate row earthing up after 1st irrigation	3325.00 a	525	6.34 a
P_4 = Flat planting in 112.3/37.5 cm apart paired rows and each row earthing up after 1st irrigation	3320.00 b	553	6.00 a
P_5 = Ridge planting	3323.00 ab	653	5.09 bc
P_6 = Bed planting	3311.00 c	615	5.39 b
LSD value	4.32	-	0.60

*I = Irrigation R = Rainfall

Means followed by the same letter in a column do not differ significantly at $P \leq 0.05$

Figure also indicates the linear correlation between water use efficiency and seed cotton yield of different planting methods. It predicts better utilization of

irrigation water by the crop plants to produce maximum economic yield in various planting methods.

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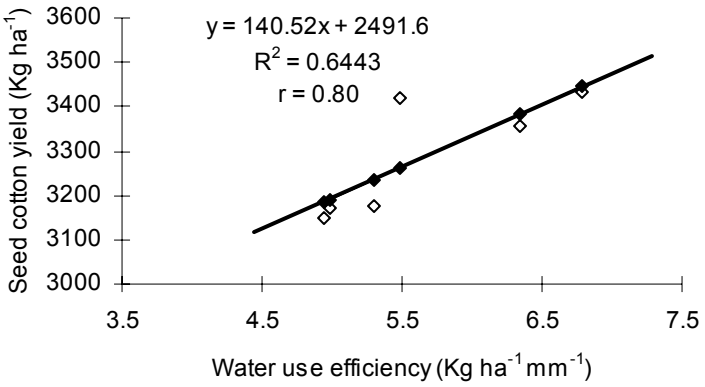
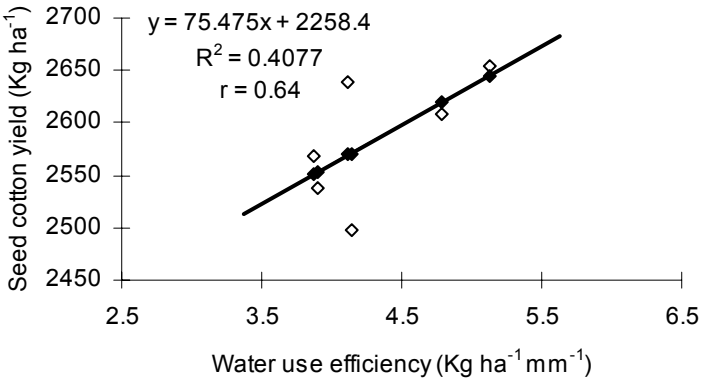
a


y = 140.52x + 2491.6
R2 = 0.6443
r = 0.80
Seed cotton yield (Kg ha-1)
3600
3500
3400
3300
3200
3100
3000
3.5
4.5
5.5
6.5
7.5
Water use efficiency (Kg ha-1 mm-1)

b


y = 75.475x + 2258.4
R2 = 0.4077
r = 0.64
Seed cotton yield (Kg ha-1)
2700
2650
2600
2550
2500
2450
2.5
3.5
4.5
5.5
6.5
Water use efficiency (Kg ha-1 mm-1)

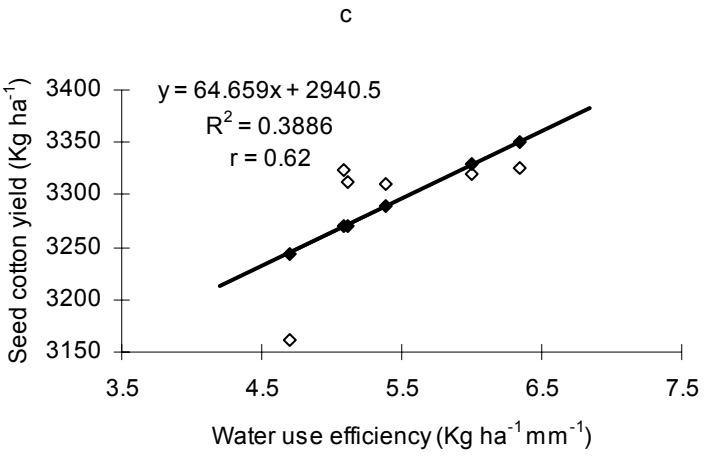


Fig. Relationship between yield and water use efficiency at location 1 (a), 2 (b), 3 (c) during 2004.