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Effect of Planting Patterns and different Irrigation Levels on Yield and Yield Component of Maize (*Zea mays* L.)

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ABSTRACT

A field experiment was carried to study the effect of two planting patterns *viz.*60 cm apart single rows and 30/90 cm apart double row strips (30 cm from row to row and 90 cm from strip to strip)] and different irrigation levels *viz.* 0, 3, 4, 5 and 6 irrigations on growth and yield of maize. Planting patterns did not influence the growth and yield of maize but different irrigation levels significantly affected number of plants per plot at harvest, number of grains per cob, 1000 grain weight, biological yield, grain yield and harvest index. Maximum grain yield (7.49 t ha^{-1}) was produced when planting spacing was kept at 30/90 cm apart; double row strips (30 cm from row to row and 90 cm from row to row) and 6 irrigations.

Key Words: Planting patterns; Irrigation levels; Yield components; Maize

INTRODUCTION

Maize (*Zea mays* L.) is an important cereal crop and ranks third in production after wheat and rice in Pakistan. Due to higher yield potential, short growing period, high value for food, forage and feed for livestock, poultry and a cheaper source of raw material for agro-based industry, it is increasingly gaining an important position in the cropping system. It has greater nutritional value as it contains about 72% starch, 10% protein, 4.8% oil, 8.5% fiber, 3% sugar and 17% ash (Chaudhry, 1983). In Pakistan maize is cultivated on an area of 961.7 thousand hectares with total annual grain production of 1731 thousand tons, and an average grain yield of 1800 kg ha^{-1} (Government of Pakistan, 2001). Although maize grain yield has increased significantly, but still there is a big gap between potential yield and actual yield of different cultivars.

Planting patterns significantly influence growth and yield of maize (Tollenaar & Aguilera, 1992). Days taken to tasseling, grain weight per cob, 1000-grain weight, dry stalk weight, and harvest index were not affected significantly by the planting geometries. While grain yield was influenced up to a measurable extent by the planting geometry (Toor, 1990).

Irrigation is an important determinant of crop yield because it is associated with many factors of the plant environment, which influence growth and development. Availability of adequate amount of moisture at critical stages of plant growth not only optimizes the metabolic process in plant cell but also increases the effectiveness of the mineral nutrients apply to the crop. Consequently any degree of water stress may produce deleterious effects on growth and yield of the crop (El-Monayeri *et al*., 1984). Water stress inhibits the growth and development of all the cultivars and hybrids of maize at different growth stages (Dai *et al*., 1990). Water stress experienced by maize is known to have cumulative effects expressed as a reduction in total biomass.

In view of importance of planting patterns and irrigation levels at different growth stages, the present study was undertaken to find their suitable combination for augmenting maize yield under agro-ecological conditions of Faisalabad.

MATERIALS AND METHODS

A field experiment to evaluate the effect of planting patterns and different irrigation levels on growth and yield of maize (*Zea mays* L.) was conducted at the Agronomic Research Area, University of Agriculture, Faisalabad. Planting patterns were 60 cm apart single row and 90 cm apart double row strips. Irrigation levels were I_0 = no irrigation, I_1 = one irrigation during vegetative growth + one irrigation at tasseling + one irrigation at silking, I_2 = three irrigations during vegetative growth + one irrigation at grain formation, I_3 = two irrigations during vegetative growth + one irrigation at tasseling + one irrigation at silking + one irrigation at maturity and I_4 = two irrigations during vegetative growth + one irrigation at tasseling + one irrigation at silking + one irrigation at grain formation + one irrigation at maturity. The experiment was laid out in randomized complete block design with split-plot arrangement, randomizing planting patterns in main plots and irrigation levels in sub plots. The net plot size was 8 x 3.6 m. The observations on growth and yield characteristics of the crop were recorded by using the standard procedures. Data collected was analyzed statistically and treatments comparison was done using Duncan’s Multiple Range (DMR) test at 5% probability level. (Steel &Torrie, 1984).

RESULTS AND DISCUSSION

Number of plants per plot at harvest. Planting patterns did not significantly affect the plant population. (Table I).

The average value varied from 166.07 to 164.47. Irrigation levels significantly affected the plant population per plot. Significantly higher numbers of plants (174.33) were recorded at irrigation level I_4 but were statistically at par with I_3, I_2 and I_1. The minimum numbers of plants (136) per plot were recorded in case of control. These results in agreement with those of Simon (1991) who reported that number of plants per m^2 were higher with high level of irrigation. Interaction affect of planting patterns and irrigation levels on number of plants per plot at harvest was also non-significant.

Number of cobs per plant. Planting patterns did not influence the number of cobs per plant (Table I). Thomson and Jordan (1995) observed significant effects of cultivars and planting patterns upon number of cobs per plant. Irrigation levels I_4 (1.23), I_3 (1.20), I_2 (1.13) and I_1 (1.05) gave statistically similar number of cobs per plant. The minimum number of cobs per plant (0.65) was produced by I_0. The interaction effect of planting patterns and different irrigation levels was also non-significant.

Number of grains per cob. Planting patterns had non-significant effect on number of grains per cob. However, number of grains per cob ranged between (452.48 to 456.44). These results are closely related to Ali (1995) who reported that planting patterns had non-significant effect on number of grains per cob, and contradictory to Aziz-ullah (1990) who reported significant effect of planting patterns on number of grains per cob. However irrigation levels significantly affected the number of grains per cob. The maximum numbers of grains (604.887) per cob were recorded in case of I_4 and minimum (153.775) from control. These findings were in accordance with the findings of Wajid (1990). Who found that high irrigation levels significantly affected numbers of grains per cob. Interaction effect of planting patterns and different irrigation levels on number of grains per cob was also non significant.

1000-grain weight (g). Planting patterns did not affect 1000-grain weight significantly. (Table I). These studies are supported by the findings of Toor (1990) who reported that planting pattern did not significantly affected 1000-grain weight but are contradicting to the findings of Ali (1995) who reported that planting patterns particularly paired rows significantly influence 1000-grain weight. Different irrigation levels had significant effect on 1000-grain weight. Significantly higher 1000-grain weight (277.73 g) was found in I_4, which is statistically different from all other treatments.

Biological yield (t ha^{-1}). The effect of planting patterns was non-significant on biological yield. (Table I) However maximum biological yield (16.66 t ha^{-1}) was obtained when the maize crop was planted in 30/90 cm apart; double row strips. The maximum biological yield (23.403 t ha^{-1}) was obtained when the crop was planted in 30/90 cm apart; double rows strips at I_4 irrigation levels. The data showed that there was a gradual increase in biological yield with increasing number of irrigation levels. At irrigation level I_4 maximum biological yield (23.37 t ha^{-1}) was achieved over I_3, I_2, I_1 and I_0 (21.11, 18.96, 15.85 and 3.94 t ha^{-1} respectively, these results are in line with the work of Puste and Kumar (1988) they reported that maize growth was more sensitive to water stress during the vegetative stage than during the grain-filling phase. Water stress may determine grain size by reducing endosperm sink capacity established during the vegetative phase.

Grain yield (t ha^{-1}). Grain yield exhibited non-significant differences in various planting patterns (Table I). Kalia (1992) reported that 60 cm apart single rows gave significantly higher yield than 30/90 cm apart double rows. Rizzardi *et al*. (1994) concluded that grain yield and yield components did not differ by spacing patterns or planting patterns.

Different irrigation levels affected the grain yield significantly. The highest grain yield (7.59 t ha^{-1}) was obtained in I_4. The lowest grain yield (0.40 t ha^{-1}) was

Table I. Effect of planting patterns and different irrigation levels on yield and yield components of maize (*Zea mays* L.)

Treatments	No.of Plants per plot at harvest	No.of cobs plant^{-1}	No.of grains cob^{-1}	1000-grain wt. (g)	Grain yield (t ha^{-1})	Biologic-al yield (t ha^{-1})	Harvest index (%)
Planting patterns							
P_1= 60 cm	166.06	1.03	452.4	204.2	4.63	16.63	24.55
P_2= 30/90 cm	164.46	1.03	456.4	204.7	4.68	16.66	25.14
LSD	*N.S*	*N.S*	*N.S*	*N.S*	*N.S*	*N.S*	*N.S*
Irrigation levels							
I_0	136.00 b	0.65 b	153.7 d	117.2 e	0.14 e	3.948 e	10.11d
I_1	170.17 a	1.05 a	420.4 c	171.4 d	4.04 d	15.85 d	25.39 c
I_2	172.33 a	1.13 a	557.4 b	205.4 c	5.12 c	18.96 c	27.2 bc
I_3	173.50 a	1.20 a	535.8 b	250.6 b	6.24 b	21.11 b	29.6 ab
I_4	174.33 a	1.23 a	604.8 a	277.7 a	7.46 a	23.37 a	31.91 a
LSD	*4.359*	*0.181*	*26.80*	*30.28*	*0.371*	*1.112*	*2.381*

I_0 = No irrigation; I_1 = One irrigation during vegetative growth + one irrigation at tasseling + one irrigation at silking; I_2 = Three irrigations during vegetative growth + one irrigation at grain formation; I_3 = Two irrigations during vegetative growth + one irrigation at tasseling + one irrigation at silking + one irrigation at maturity; I_4 = Two irrigations during vegetative growth + one irrigation at tasseling + one irrigation at silking + one irrigation at grain formation + one irrigation at maturity; $^{N.S}$ = Non-significant; Any two means not sharing a common letter differ significantly at 5% level of significance recorded in control. These results are inconformity with those of Ghinassi and Trucchi (1999) who reported that maize pollination was particularly sensitive to water stress from the last vegetative period. Other parameters such as plant height, lodging percentage and commercial grain yield were also affected by water stress. Interaction effect of planting patterns and different irrigation levels on grain yield was non-significant.

Harvest index (%). Planting patterns had non-significant effect on harvest index (Table-1). These results are quite in line with those of Toor (1990) but contradictory to that of Graybill *et al*. (1991) who reported that planting patterns differ significantly with regard to harvest index. Various irrigation levels significantly affected harvest indices. There was progressive increase in harvest indices with each successive increase in irrigation. I_4 levels showed the highest harvest index (31.912 %), which was statistically at par with I_4 (29.6 %). Similarly I_3 and I_2 are also statistically at par but I_2 is statistically different from I_4. Lowest harvest index (10.11 %) was observed in control. These results are in line with Wajid (1990), who reported that harvest index was affected significantly by irrigation frequencies.

CONCLUSIONS

It can be concluded that planting pattern of 30/90 cm apart double row strips and irrigation level I_5 (two irrigations during vegetative growth + one irrigation at tasseling + one irrigation at silking + one irrigation at grain formation + one irrigation at maturity) in combination, were found to be more efficient as compared to other treatments.

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