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Effect of Irrigation Methods and Regimes on Maize (*Zea Mays* L.) growth

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Abstract: *Different irrigation methods and regimes affect maize (*Zea Mays *L.) growth differently. The field experiment was conducted to study the interactive effect of three irrigation methods and three irrigation regimes on maize growth under sandy loam soil at the Research Farm of Department of Soil Science, Punjab Agricultural University, Ludhiana. The irrigation methods includes drip, furrow and ridge while, the three irrigation regimes includes IW/PAN-E ratio of 1.0, 1.25 and 1.5 under furrow and ridge and 0.2, 0.3 and 0.4 under drip irrigation. The maize plant height (cm) was observed to be more under drip irrigated plots (251.4) followed by furrow irrigated (225.2) and ridge (214.5) irrespective of irrigation regimes. The root length density was observed to be more in surface soil layer (0-10 cm) under drip irrigated beds, while at lower soil depths higher root length density was observed in furrow irrigation. The highest thousand grain weight of 255.0 g was observed in drip irrigated plots followed by furrow irrigated (242.9 g) and ridge method (228.3 g). Irrespective of irrigation methods, highest thousand maize grain weight (g) were recorded at IW/PAN-E ration I3 i.e. 258.1 followed by I2 (241.6) and I1 (226.6). The maize stover yield (t ha*$^{-1}$*) was also observed to be higher under drip irrigation (13.0) as compared to furrow (11.3) and ridge (9.9) irrigation. Root length density was observed to be higher at surface soil layer under drip irrigation, while the reverse was true under furrow irrigation at sub surface soil layer.*

Key words: *Drip irrigation, furrow irrigation, ridge, maize, plant height, stover yield.*

INTRODUCTION

Maize (*Zea Mays* L.*)* cultivation requires proper irrigation methods and scheduling for higher productivity. Improper use of water has contributed extensively to the current water scarcity in many parts of the world, and is also a serious challenge to future food security. Most of the maize in India is irrigated and is grown under low rainfall and heat stress conditions. In these conditions, irrigation is the major factor determining yield. It is consequently essential to determine the water regimes leading to highest yield. Maize has been reported in the literature to have high irrigation requirements (Karam et al 2003). Maize grain yield increased significantly by irrigation water amount and frequency (Kara and Biber, 2008). Maize has been reported to be very sensitive to drought (Otegui et al., 1995). Water stress can affect growth, development, and physiological processes of maize plants, which can reduce biomass and, ultimately, grain and stover yield due to a reduction in the number of kernel per ear (cob) or the kernel weight (Payero *et al*., 2008). The water availability is usually the most important natural factor limiting expansion and development of agriculture in northern western region of India. Drip irrigation method is becoming more popular because of numerous advantages over other methods (Hanson *et al.*, 1997). Some advantages of drip irrigation over other irrigation methods include improved water management, potential for improved yields and crop quality, greater control on applied water resulting in less water and nutrient loss through deep percolation, and reduced total water requirements (Dogan and

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Kirnak., 2010). The main aim of this study is to examine the effect of different irrigation methods and regimes on maize plant growth and stover yield.

MATERIAL AND METHODS

The study was conducted at the research farm of the Department of Soil Science, PAU, Ludhiana, Punjab, India (30°56′N latitude, 70° 52′E longitude and 247 m above mean sea level). The region experiences semi-arid climate with extremely hot during summers and cold during winter. The annual average temperature is 18.7 ºC and annual average total precipitation is 700 mm. The soils in the research field are deep, medium textured and well drained. The percentage of sand, silt and clay in the experimental soil were 69.5, 19.8 and 10.7 respectively. Field capacity, wilting point and bulk density of top 30 cm of the soil were 19.2%, 9.4% and 1.58 Mg m^{-3}. Basic intake rate was measured by double ring infiltrometer and found as 1.6 cm hr^{-1}. The treatments consisted of three methods of irrigation (drip, furrow and ridges) and three levels of irrigation i.e., IW/PAN-E ratio of 1.0, 1.25 and 1.5 for furrow irrigation and ridge methods, while 0.2, 0.3 and 0.4 were maintained under drip irrigated beds. All other agronomic practices were kept uniform for all treatments. Maize was ready for harvest when the leaves collapsed.

RESULTS AND DISCUSSION

Plant height

The maize plant height was significantly affected by both irrigation methods and regimes (Table 1). Drip irrigation produced large size plants than other two methods. Irrespective of irrigation levels, maximum plant height (cm) were observed in drip irrigation (251.4 cm) followed by furrow irrigation (225.2) and ridge method (214.5). Irrespective of irrigation methods maximum plant height was observed under I3 treatment i.e. 244.8 cm, followed by I2 (228.0 cm) and I1 (218.0 cm) treatments. At most frequent irrigation regime i.e. I3 the drip irrigation produced 17 and 9% higher plant height as compared to ridge and furrow irrigated plots respectively. Irfan *et al.* (2014) observed higher plant height under in drip irrigation (221.0 m) as compared to raised bed irrigated plots (205.0 cm).

Root length density

Root length density (cm cm^{-3}) (RLD) was observed to be significantly affected both by planting methods and levels (Table 2). Under drip irrigated beds higher RLD (1.046 cm cm^{-3}) was observed at surface soil layer (0-10 cm), however, under furrow irrigation greater RLD was observed at lower soil depths. Higher rooting density at surface soil in drip irrigation may be due to higher volumetric water content, whereas reverse was true under furrow and ridge irrigation (Figure 2). RLD (cm cm^{-3}) was observed to be 0.962, 0.376, 0.186, 0.141, 0.095 and 0.064 at 10, 20, 30, 40, 50 and 60 cm depths respectively under furrow irrigation method. Least root length density was observed under ridge irrigation method.

Thousand grain weight

The thousand grain weight of maize was significantly affected by both irrigation levels and planting methods (Table 2). Drip irrigation produced highest thousand grain weight than other two methods. Irrespective of irrigation levels, maximum thousand grain weight was observed in drip (255.0 g) followed by furrow (242.9 g) and lowest under ridge method (228.3 g). Under ridge planting, 217.7, 226.3 and 241.0 g of thousand grain weight was recorded at IW/PAN-E ratios of 1.0, 1.25 and 1.5 respectively (Table 2). Under drip 237.7, 254.3 and 273.0 g thousand grain weight was recorded at 0.2, 0.3 and 0.4 IW/PAN-E ratios, respectively. However, irrespective of irrigation methods maximum thousand grain weight was observed under I3 treatment i.e. 258.1 g, followed by I2 (241.6 g) and least under I1 (226.6 g) treatments.

Stover yield

The maize stover yield was also observed to be significantly affected by both irrigation levels and planting methods (Table 3). Drip irrigation produced highest maize stover yield than other two methods. Irrespective of irrigation regimes, maximum maize stover yield was observed in drip (13.0 t /ha) followed by furrow (11.3 t/ha) and ridge

Table 1
Effect of irrigation methods and regimes on maize plant height (cm)

Irrigation methods	*Irrigation regimes* I1	I2	I3	*Mean*
Drip	235.4	249.3	268.8	251.4
Furrow	215.8	218.1	241.7	225.2
Ridge	203.0	216.7	223.8	214.5
Mean	218.0	228.0	244.8	

LSD (< 0.05)Methods of irrigation = 9.6 ; Irrigation level = 6.7 ; Interaction = NS

Table 2
Thousand grain weight (g) of maize under different irrigation methods and regimes

Irrigation methods	*Irrigation regimes* I1	I2	I3	*Mean*
Drip	237.7	254.3	273.0	255.0
Furrow	224.3	244.0	260.3	242.9
Ridge	217.7	226.3	241.0	228.3
Mean	226.6	241.6	258.1	

LSD (< 0.05)Methods of irrigation = 7.4; Irrigation levels = 5.5 ; Interaction =NS

Table 3
Effect of irrigation methods and regimes on maize stover yield (t ha^{-1})

Irrigation methods	*Irrigation regimes* I1	I2	I3	*Mean*
Drip	11.8	13.2	14.1	13.0
Furrow	9.7	11.4	12.7	11.3
Ridge	9.4	9.8	10.5	9.9
Mean	10.3	11.5	12.4	

LSD (< 0.05)Methods of irrigation = 1.42; Irrigation level = 0.83; Interaction = NS

method (9.9 t/ha). Under ridge planting, 9.4, 9.8 and 10.5 t/ha of stover yield was recorded at IW/PAN-E ratios of 1.0, 1.25 and 1.5 respectively (Table 3). Under drip 11.8, 13.2 and 14.1 t/ha stover yield was recorded at 0.2, 0.3 and 0.4 IW/PAN-E ratios, respectively. However, irrespective of irrigation methods maximum stover yield was observed under I3 treatment i.e. 12.4 t/ha, followed by I2 (11.5 t/ha) and least under I1 (10.3 t/ha) treatments. Fanish (2013) reported 39% higher maize yield with

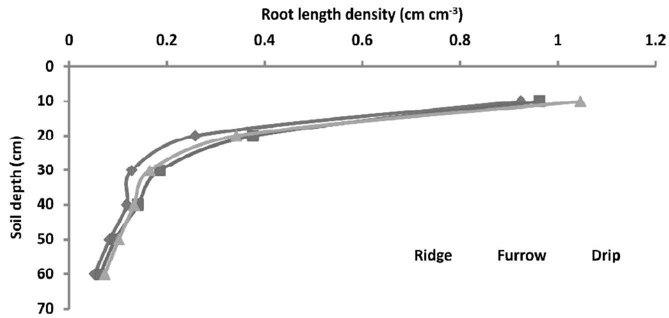

Figure 1: Effect of different irrigation methods on root length density

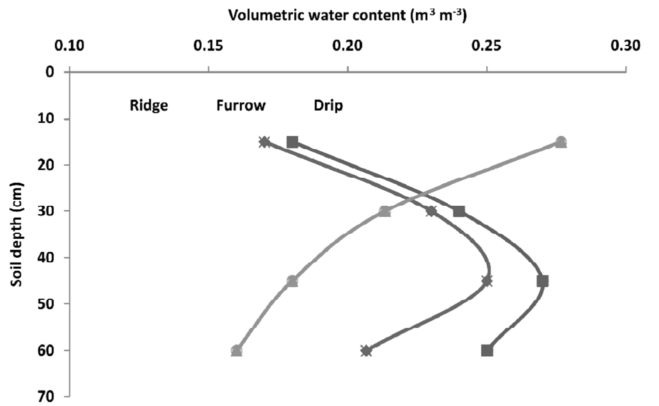

Figure 2 : Effect of different irrigation methods on volumetric water content of soil

drip irrigation as compared to surface irrigation. Ahamd *et al*. (2011) reported that on an average there was 19% increase in maize grain yield under bed planting than ridge planting method with 32% water saving. Leyenaar and Hunter (1977) reported that low soil moisture and high soil temperature caused reduction in yield of maize under ridge planting method. It could be concluded that drip irrigation leads to more plant height, rooting density and stover yield as compared to furrow and ridge irrigations.

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