Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.5912

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **6 (1):** 183-191 (2018)

Research Article

International Journal of Pure & Applied Bioscience

OPEN ACCESS

Effect of Drip Irrigation Schedules and Plastic Mulching on Plant Growth, Yield and Leaf Water Potential of *Rabi* Maize

Swathi Priya[*], N., Ramulu, V., Praveen Rao, V. and Uma Devi, M.

Water Technology Centre, College of Agriculture,

Professor Jayashankar Telangana State Agricultural University (PJTSAU), Hyderabad

*Corresponding Author E-mail: swathi.agbs@gmail.com

Received: 20.10.2017 | Revised: 29.11.2017 | Accepted: 4.12.2017

ABSTRACT

A field experiment was conducted at Water Technology Centre, College of Agriculture, Rajendranagar, Hyderabad during rabi 2014-15 to study the " Effect of drip irrigation schedules and plastic mulching on plant growth, yield and leaf water potential of rabi maize". The experiment was conducted in a randomized block design with eight treatments in three replications. The treatments comprises of drip irrigation schedules and plastic mulching viz., drip irrigation equivalent at 100%, 80% and 60% pan evaporation replenishment each with and without plastic mulch and surface furrow irrigation at 0.8 IW/CPE ratio with plastic mulch and surface furrow irrigation at 1.0 IW/CPE ratio without plastic mulch. The experimental soil was sandy clay loam in texture, slightly alkaline in reaction and non-saline. At harvest, significantly higher plant height (284.67 cm) and dry matter production (251.61 g plant^{-1}) of maize was observed in drip irrigation scheduled at 100% pan evaporation replenishment with plastic mulching (I_1) followed by 80% pan evaporation with plastic mulch (I_3) and surface furrow irrigation at 0.8 IW/CPE ratio with plastic mulch compared to all other irrigation schedules at all growth stages except at 30 DAS. Significantly higher grain yield (7447 kg ha^{-1} respectively) of maize were realized in drip irrigation scheduled equivalent at 100% pan evaporation replenishment with plastic mulching (I_1) compared to all other irrigation schedules without plastic mulch. Higher leaf water potential was observed before irrigation(-10 to -13 cbars) and after irrigation(-8 to -11cbars) in drip irrigation scheduled at 100% pan evaporation with plastic mulch compared to all other irrigation schedulings followed by drip irrigation at 80% pan evaporation with plastic mulch and 60% pan evaporation with plastic mulch. The present study concluded that rabi grown maize when irrigated with drip irrigation scheduled at 100% pan evaporation replenishment with plastic mulching (I_1) realized higher plant height, dry matter production, grain yield and leaf water potential.

Key words: *Drip irrigation schedules; Plastic mulching; Plant height; Dry matter; Leaf water potential*

Cite this article: Swathi Priya, N., Ramulu, V., Rao, P.V. and Uma Devi, M., Effect of Drip Irrigation Schedules and Plastic Mulching on Plant Growth, Yield and Leaf Water Potential of *Rabi* Maize, *Int. J. Pure App. Biosci.* **6(1):** 183-191 (2018). doi: http://dx.doi.org/10.18782/2320-7051.5912

INTRODUCTION

In India, *rabi* maize is grown in area of 1.62 m ha with a production of 6.51 m t and productivity of 4.00 t ha^{-1} (Directorate of Economics and Statistics, 2015-16). Maize is a water demanding crop and under good management, the grain yields ranges from 4 - 6 t ha^{-1}, when water and nutrients are not limiting. Application of water through drip irrigation provides the efficient use of applied water and helps in maintaining the optimum soil moisture in root zone and results in increased yield and water use efficiency[12]. Mulch is any material when applied to the soil surface known to increase the crop yields by providing surface cover to soil, minimize the evaporation, regulate the soil temperature and supress the weeds. Plastic mulch is a product used in a similar fashion to mulch, to supress weeds and conserve water in crop production in conjunction with drip irrigation.

MATERIALS AND METHODS

A field experiment entitled " Effect of drip irrigation schedules and plastic mulching on plant growth, yield and leaf water potential of *rabi* maize" was conducted during *rabi* , 2014-15.The experiment was carried out at Water Technology Centre, College Farm, College of Agriculture, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad. The experimental soil was sandy clay loam in texture, slightly alkaline in reaction with (pH 7.69) and non-saline (EC of 0.121dS m^{-1}). The fertility status of the experimental soil was medium in organic carbon (0.57%), low in available nitrogen(139.37kg ha^{-1}), high in available P_2O_5 (152.78 kg ha^{-1}) and K_2O (458.30 kg ha^{-1}).The experiment was conducted in a randomized block design with eight treatments in three replications. The treatments comprises of drip irrigation schedules and plastic mulching viz., drip irrigation equivalent to 100%, 80% and 60% pan evaporation replenishment each with and without plastic mulch and surface furrow irrigation at 0.8 IW/CPE ratio with plastic mulch and surface furrow irrigation at 1.0 IW/CPE ratio without plastic mulch. The drip system consisted of 12 mm dripper line with inline emitters, laid at 1.2 m apart with spacing of 0.4 m distance between two emitters. The emitter discharge rate was 2.0 lph. Polythene mulch of 25 micron thickness with dual surface black was used for imposing different mulch treatments. Polythene mulch was covered on the row length with 60% ground coverage.Maize hybrid DEKLAB 900M (120 days duration) was used in the experiment. Seeds were sown manually by hand dibbling at 4-5 cm depth in paired row planting (80 cm/40 cm) and 20 cm between the plants in drip irrigated plots and 60 cm uniform row spacing with 20 cm plant to plant spacing in surface furrow irrigated plots in order to maintain a uniform plant population of 83,333 plantsha^{-1}. The irrigation scheduling was done based on pan evaporation replenishment at 100 %, 80 % and 60% in treatments I_1 to I_6 and IW/CPE ratio of 0.8 and 1.0 in treatments I7 and I8, respectively. The irrigation water was applied on the basis of pan evaporation (PE) data (USWB open pan evaporimeter) obtained from the Agromet center, ARI, Rajendranagar, Hyderabad. In drip irrigation system, irrigation water was given at 3 days interval while in surface irrigation (I_7 and I8) IW/CPE ratio of 0.8 and 1.0, the depth of irrigation water applied in each irrigation was 50 mm and irrigation was rescheduled whenever the cumulative pan evaporation (CPE) reached to 62.5 and 50 mm,respectively. During rainy days the volume of water applied to each treatment was adjusted for the effective rainfall received.

$$\text{Application rate (mm h}^{-1}\text{)} = \frac{Q}{D_E \times D_L}$$

Where as

Q = Dripper discharge (L h-1)

D_L = Distance between lateral spacing (m)

D_E = Distance between dripper spacing (m)

$$\text{Irrigation time (minutes)} = \frac{\text{Pan evaporation (mm)}}{\text{Application rate (mm h-1)}} \times 60$$

The recommended dose of fertilizers (200-80-80 kg N-$P_2 0_5$-$K_2 0$ ha^{-1}) was applied uniformly to all the treatments. The source of fertilizers used were urea for nitrogen, single super phosphate for phosphorous and potassium nitrate for potassium. The entire dose of phosphorous was applied to soil as a basal in all the treatments whereas, nitrogen and potassium were applied through fertigation at weekly intervals in drip irrigated plots. While, in surface furrow irrigated plots, the entire nitrogen and potassium were applied in three equal splits one each at basal, knee high stage and at taselling. Maize cobs were harvested when the sheath of the cob was dried completely. Then the decobed stalks in net plot were cut and kept as heap for sun drying. The harvested cobs were dehusked, dried and shelled mechanically for recording grain weight. Data was recorded on plant height (cm), dry matter (g $plant^{-1}$), grain yield (kg ha^{-1}) and leaf water potential. Plant height was recorded from five selected plants at 30, 60, 90 DAS and at harvest from the base of the plant to the ligule of the last leaf before taselling and upto the tip of the tassel after tassel emergence and expressed in cm. From each plot, five plants from the sampling row were uprooted carefully at 30, 60, 90 DAS and at harvest and roots were removed from basal portions. The samples were first air dried in shade for one day and then oven dried at 60^0C till a constant weight was obtained. The mean dry weight of plant samples was expressed as g $plant^{-1}$. Leaf water potential (0 to 40 bars) was recorded before and after each irrigation by using pressure chamber method (Plant water console-model 3115 Soil moisture Equipment crop., USA) for randomly collected leaves in each plot.

RESULTS AND DISCUSSION

Plant Height (cm)

The data pertaining to the plant height of maize presented in Table 1 indicated that the plant height of maize was progressively increased with the advancement of crop age up to harvest, irrespective of the treatments. The plant height of maize was significantly influenced by irrigation schedules at all the growth stages except at 30 DAS. The irrigation schedules were not imposed in the initial two weeks duration to ensure uniform population in all the plots, equal quantity of irrigation water was applied in all the treatments. There by the treatmental influence on plant height was not noticed at 30 DAS. The rate of increase was slow in the initial period (upto 30 DAS), increased at increasing rate from 30 DAS to 60 DAS and thereafter increased at decreasing rate.

Table 1: Influence of drip irrigation schedules and plastic mulching on plant height (cm)of maize during *rabi*, 2014-15

Irrigation scheduling treatments	Plant height(cm)			
	30 DAS	60 DAS	90DAS	Harvest
I_1- Drip Irrigation equivalent at 100% panevaporation with plastic mulch	88.1	262.1	279.1	284.7
I_2- Drip Irrigation equivalent at 100% pan evaporation without plastic mulch	85.9	242.5	254.7	275.5
I_3- Drip Irrigation equivalent at 80% pan evaporation with plastic mulch	85.7	260.4	278.4	282.2

I_4- Drip Irrigation equivalent at 80% pan evaporation without plastic mulch	85.0	229.4	231.0	251.7
I_5- Drip Irrigation equivalent at 60% pan evaporation with plastic mulch	81.7	258.2	270.3	280.3
I_6- Drip Irrigation equivalent at 60% pan evaporation without plastic mulch	80.9	193.6	209.0	212.7
I_7- Surface furrow irrigation at 0.8 IW/CPE ratio with plastic mulch	83.4	260.1	278.3	282.1
I_8- Surface furrow irrigation at 1.0 IW/CPE ratio without plastic mulch	82.6	202.7	219.1	222.9
SEm±	10.4	0.7	0.6	1.1
CD (P=0.05)	NS	2.2	1.9	3.4

At 60 DAS, significantly higher plant height (262.07 cm) of maize was observed in drip irrigation scheduled equivalent to 100% pan evaporation replenishment with plastic mulching (I_1) compared to all other irrigation schedules without plastic mulch. Whereas, the plant height (260.40 cm) noticed with drip irrigation scheduled at 80% pan evaporation with plastic mulch (I_3) and surface furrow irrigation at 0.8 IW/CPE ratio with plastic mulch (260.10 cm) were at par with drip irrigation scheduled at 100% pan evaporation with plastic mulch. Drip irrigation scheduled equivalent to 60% pan evaporation without plastic mulch realized the lowest plant height (193.60 cm) among all the treatments tested. Similar trend was noticed at 90 DAS with respect to plant height.Similarly, at harvest also significantly higher plant height (284.67 cm) of maize was observed in drip irrigation scheduled at 100% pan evaporation replenishment with plastic mulching (I_1) compared to all other irrigation schedules without plastic mulch. However, the plant height (282.17 cm) noticed with drip irrigation scheduled at 80% pan evaporation with plastic mulch (I_3) and surface furrow irrigation at 0.8 IW/CPE ratio with plastic mulch (282.10 cm) were at par with drip irrigation scheduled at 100% pan evaporation with plastic mulch. Drip irrigation scheduled equivalent to 60% pan evaporation without plastic mulch realized the lowest plant height (212.67 cm) among all the treatments studied.

The increased plant height observed at higher level of drip irrigation might be due to relatively more water application coupled with the mulching which prevented the evaporation losses and weed growth facilitating maximum utilization of conserved moisture by plants. Increased frequency of irrigation and increase in total amount of water supply led to effective absorption and utilization of nutrients resulting in quick growth[10]. Availability of sufficient soil moisture at different growth stages due to irrigation enhanced the growth of plant. Similar effect of increased irrigation drip irrigation levels on plant height was also reported by Shirazi *et al*.[11] and Awasthy *et al*.[1].

Dry Matter (g plant^{-1})

The data obtained on the dry matter production of maize presented in Table 2, indicates that the dry matter production increased progressively with advancement in the age of the crop up to 90 days and then it decreased as the crop attained maturity. At 30 DAS, dry matter production of maize was not significantly influenced by irrigation schedules. Whereas, at 60,90 DAS and harvest, dry matter production of maize was significantly influenced by irrigation schedules. Significantly higher dry matter production (112.7 g plant^{-1}) of maize was observed in drip irrigation scheduled equivalent to 100% pan evaporation replenishment with plastic mulching (I_1) compared to all other irrigation schedules without plastic mulch. Whereas, the dry matter production (112.5 g plant^{-1}) noticed with drip irrigation scheduled at 80% pan evaporation with plastic mulch (I_3) and surface furrow irrigation at 0.8 IW/CPE ratio with plastic mulch(112.4 g plant^{-1}) were at par with drip irrigation scheduled at 100% pan evaporation with plastic mulch. Drip irrigation scheduled equivalent to 60% pan evaporation without plastic mulch realized lowest dry matter production (101.3 g plant^{-1}) among all the treatments tested. The same trend was observed at 90 DAS in respect of dry matter production.

At harvest, significantly higher dry matter production (251.6 g plant^{-1}) of maize was observed in drip irrigation scheduled equivalent to 100% pan evaporation replenishment with plastic mulching (I_1) compared to all other irrigation schedules without plastic mulch. Whereas, the dry matter production (250.6 g plant^{-1}) noticed with drip irrigation scheduled at 80% pan evaporation with plastic mulch (I_3) and surface furrow irrigation at 0.8 IW/CPE ratio with plastic mulch (250.2 g plant^{-1}) were at par with drip irrigation scheduled at 100% pan evaporation with plastic mulch. The lowest dry matter production (239.8 g plant^{-1}) was noticed with drip irrigation scheduled equivalent to 60% pan evaporation without plastic mulch among all the treatments tested.

The micro-climate conditions improved by mulches might have facilitated suitable conditions for more height and more no of leaves in the plants resulting higher dry matter production over the respective irrigation regimes without mulch. Higher leaf number, expansion[3] and duration of leaf area coupled with higher light interception (69.85%) under adequate moisture condition with higher level of irrigation and moisture conservation under mulching have contributed for more dry matter accumulation[5]. Increase in dry matter was mainly due to frequent irrigations and more availability of water throughout the crop season and thus no water stress occurred[9].Greater accumulation of dry matter at an early stage of growth such as pre-silking stage, the dry matter accumulation rate was improved substantially by plastic mulching[13].

Grain Yield(kg ha^{-1})

Perusal of data pertaining to grain yield of maize as influenced by irrigation schedules with and without plastic mulching presented in (Table 1) indicates that the grain yield of maize

(7447 kg ha^{-1}) of maize was significantly higher in drip irrigation scheduled at 100% pan evaporation replenishment with plastic mulching (I_1) compared to all other irrigation schedules without plastic mulch. Whereas, the grain yield (7361 kg ha^{-1}) noticed with drip irrigation scheduled at 80% pan evaporation with plastic mulch(I_3), 60% pan evaporation with plastic mulch (I_5) and surface furrow irrigation at 0.8 IW/CPE ratio with plastic mulch (7069 kg ha^{-1}) were at par with drip irrigation scheduled at 100% pan evaporation with plastic mulch. Drip irrigation scheduled at 60% pan evaporation without plastic mulch realized the lowest grain yield (6117 kg ha^{-1}) among all the treatments tested. Increase in grain yield under drip irrigation was mainly due to increased soil moisture status maintained in the upper 40 cm soil layer consequently higher plant relative water content and less negative leaf water potential[12]. Film mulching could have maintained favourable water, fertilizer and suppressed the weed growth, there by improved the yield[7]. Grain yields were significantly more with mulching than with no mulching because of greater soil- moisture storage and its extraction in the former[4].

Table 2: Influence of drip irrigation schedules and plastic mulching on dry matterproduction (g plant^{-1}) and grain yield (kg ha^{-1}) of maize during *rabi*, 2014-15

Irrigation scheduling treatments	Dry Matter (g plant^{-1})				
	30 DAS	60 DAS	90 DAS	Harvest	Grain Yield (kg ha^{-1})
I_1- Drip Irrigation equivalent at 100% panevaporation with plastic mulch	76.0	112.7	273.5	251.6	7448
I_2- Drip Irrigation equivalent at 100% pan evaporation without plastic mulch	75.8	103.4	262.8	243.2	6615
I_3- Drip Irrigation equivalent at 80% pan evaporation with plastic mulch	75.9	112.5	271.3	250.6	7361
I_4- Drip Irrigation equivalent at 80% pan evaporation without plastic mulch	75.4	101.7	262.7	241.9	6262
I_5- Drip Irrigation equivalent at 60% pan evaporation with plastic mulch	75.7	110.2	268.3	245.2	7056
I_6-Drip Irrigation equivalent at 60% pan evaporation without plastic mulch	75.3	101.3	253.6	239.8	6117
I_7- Surface furrow irrigation at 0.8 IW/CPE ratio with plastic mulch	75.6	112.4	270.3	250.2	7069
I_8- Surface furrow irrigation at 1.0 IW/CPE ratio without plastic mulch	75.1	101.6	260.3	240.6	6397
SEm±	0.2	0.5	1.6	1.0	226
CD (P=0.05)	NS	1.4	4.8	3.2	686

The higher grain yield obtained with drip irrigation at 1.0 E pan with fertigation of 100% RDF water soluble fertilizers might be due to increased nutrient dynamics in the root zone and in plants under drip fertigation[8]. The lowest grain yield found in drip irrigation equivalent at 60% pan evaporation without plastic mulch could be ascribed to moisture stress as a result of deficit irrigation scheduling practiced during entire growth period resulted in lower plant height, leaf area and dry matter led to lesser photosynthesis and ultimately lower yield attributes and yield[6].

Leaf Water Potential (c bars)

The periodical leaf water potential monitored before and after irrigation as per each irrigation scheduling depicted in Figure 1(a) to (d) showed that higher leaf water potential was observed before irrigation at 100% pan evaporation with plastic mulch (-10 to-13 c bars) compared to all other irrigation scheduling followed by 80% pan evaporation with plastic mulch(-13 to -15 c bars) and 60% pan evaporation with plastic mulch (-14 to -17 c bars). Whereas, drip irrigation scheduled at 60% pan evaporation without plastic mulch recorded lower leaf waterpotential (-19 to -22 c bars).Similarly, leaf water potential observations made after each irrigation indicates that drip irrigation scheduled at 100% pan evaporation with plastic mulch recorded higher leaf water potential (-8 to -11cbars) compared to all other irrigation schedulings followed by 80% pan evaporation with plastic mulch (-10 to -13 C bars) and 60% pan evaporation with plastic mulch (-11 to -14 C bars). On the other hand, drip irrigation scheduled at 60% pan evaporation without plastic mulch recorded lower leaf water potential (-17 to -20.5 c bars). Whereas, surface furrow irrigation scheduled at 0.8 IW/CPE ratio with plastic mulch and surface furrow irrigation at 1.0 IW/CPE ratio without plastic mulch maintained higher leaf water potential (-9 to -11 bars) after irrigation as higher water application depth (50 mm) per irrigation recouped the soil moisture to field capacity but showed low leaf water potential before irrigation as crop plants sensed moisture stress at higher depletion level as a consequence of longer intervals between irrigations.

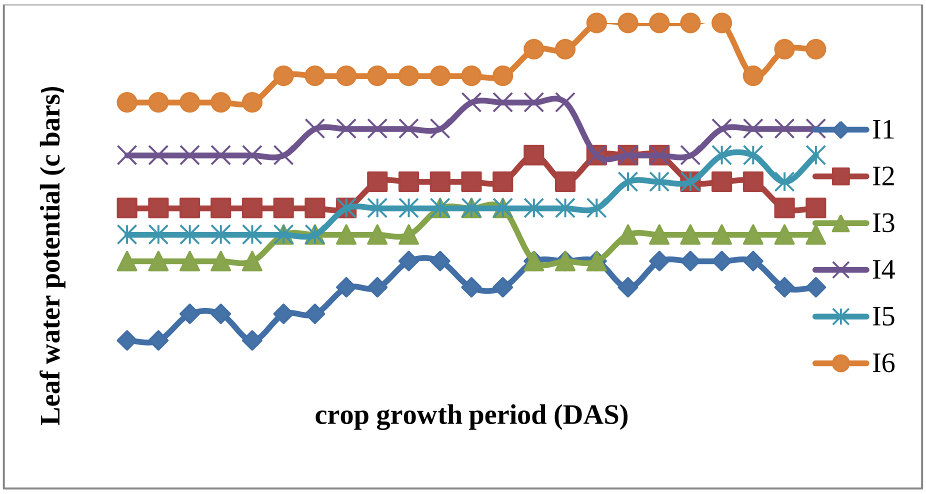

Fig. 1(a): Leaf water potential observed before irrigation during crop growth period at drip irrigation scheduled to 100%, 80% and 60% pan evaporation equivalent with and without plastic mulch

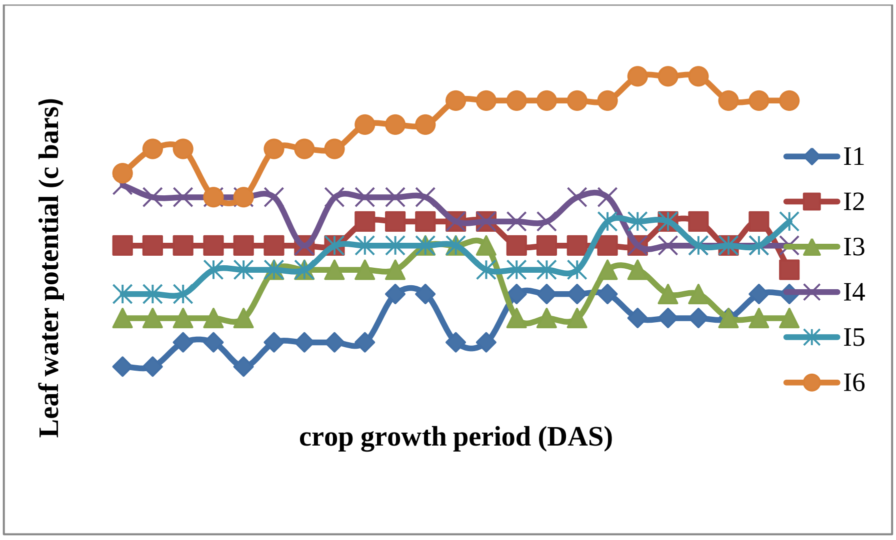

Fig. 1(b): Leaf water potential observed after irrigation during crop growth period at drip irrigation scheduled to 100%, 80% and 60% pan evaporation equivalent with and without plastic mulch

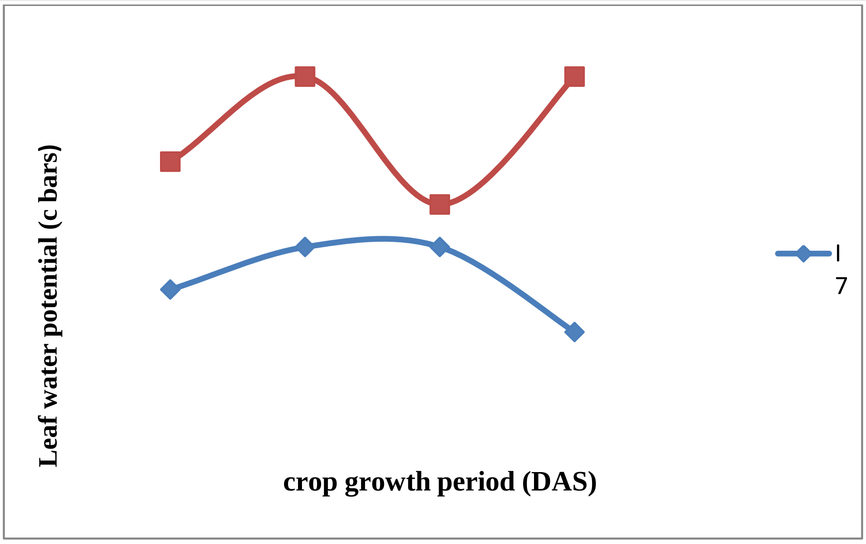

Fig. 1 (c): Leaf water potential observed before irrigation during crop growth period in surface furrow irrigation at 0.8 IW/CPE ratio with plastic mulch(I_7) and surface furrow irrigation at 1.0 IW/CPE without plastic mulch (I_8)

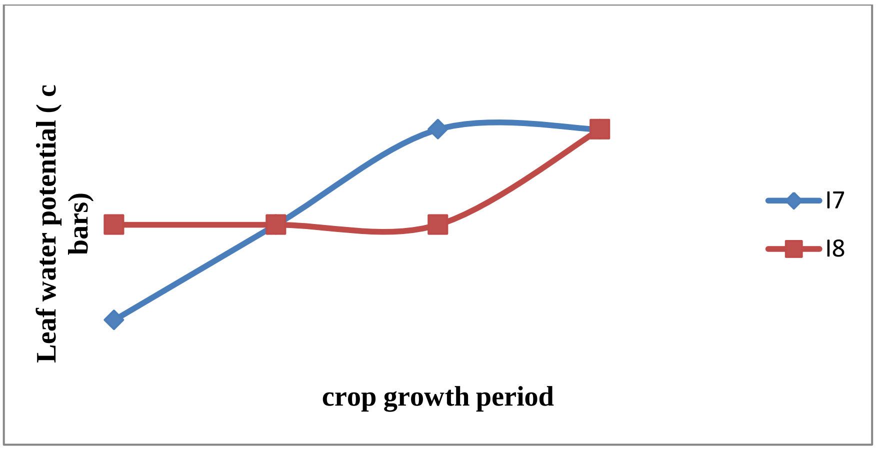

Fig. 1 (d): Leaf water potential observed after irrigation during crop growth period in surface furrow irrigation at 0.8 IW/CPE ratio with plastic mulch (I_7) and surface furrow irrigation at 1.0 IW/CPE without plastic mulch (I_8)

CONCLUSION

The present study concluded that significantly higher plant height, dry matter production and leaf water potential observed in drip irrigation scheduled at 100% pan evaporation replenishment with plastic mulching (I_1) compared to all other irrigation schedules led to realization of significantly higher *rabi* maize grain yield.

REFERENCES

1. Awasthy, P., Bhambri, M.C., Dwivedi, S.K and Patel, B., Growth parameters, grain yield and economics of maize (*Zea mays* L.) as influenced by different mulches and irrigation scheduling under drip. *Current Advances in Agricultural Sciences*. **7(1):** 37-40 (2015).
2. Directorate of Economics and Statistics. Agricultural Statistics at a Glance. Department of Agriculture and Cooperation, Government of India, New Delhi (2015-16).
3. Izakovic, R., Effect of plastic mulch on the yield and some traits of maize lines. *Rostinna Vyroba*. **35:** 973-980 (1989).
4. Jadhav, B.S., Jadhav, A.S and Jadhav, S.B., Effect of irrigation schedule, method and mulching on yield of and nutrient uptake by maize (*Zea mays*). *Indian Journal of Agricultural Sciences*. **62(7):** 472-5 (1992).

5. Kumar, S and Gomrokchi, A. Yield and yield components of wintermaize (*Zea mays* L.) as influence by plant density and nitrogen levels. *Agricultural Science Digest.***17:** 181-184(2011).
6. Maiti, R.K., Singh, V.P., Wesche-Ebeling, P., Sanchez- Arreola, E., Hernandez, T and Aguilar- Najera, E., Research advances on cold, drought and salinity tolerance and its mechanisms of resistance in maize. *Crop Research*. **27(1):** 1-29 (2004).
7. Mi-juan, G., Cheng-qun, Y., Hua-ping, Z., Yan-bin, J., Mu-la, C., Jie, B., Yu-lei, Z. and Xiao-ming, S. 2010. Effect of film mulching on the growth of silage maize and weed. *Agricultural Science & Technology*. **11(7):** 66-68, (2010).
8. Mmolawa, K.B and Or, D., *Plant and Soil*. **222:** 163-190 (2000).
9. Reddy, M.M and Padmaja, B. Productivity and water use efficiency of no-till winter *(rabi*) maize (*Zea mays*) as influenced by drip-fertigation. *Indian Journal of Agronomy*. **59(1):** 96-100 (2014).
10. Selvaraju, R and Iruthayaraj, M.R. Influence of irrigation scheduling, methods of irrigation and nitrogen levels on growth and yield of maize. *Madras Agricultural Journal.* **81(8):** 418-420 (1994).
11. Shirazi, S.M., Sholichin, M., Jameel, M., Akib, S and Azizi, M. Effect of different irrigation regimes and nitrogenous fertilizers on yield and growth parameters of maize. *International Journal of Physical Sciences*. **6(4):** 677-683 (2011).
12. Viswanatha, G.B., Ramachandrappa, B.K and Nanjappa, H.V. Soil plant water status and yield of sweet corn (*Zea mays*L.cv.*Saccharata*) as influenced by drip irrigation and planting methods. *Agricultural Water Management*. **55:** 85-91(2002).
13. Xu, J., Li, C., Liu, H., Zhou, P., Tao, Z., Wang, P., Meng, Q and Zhao, M. 2015. The effect of plastic film mulching on maize growth and water use in dry and rainy years in northeast china. *Plos One.* **10(5):** (2015).