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PERFORMANCE OF MAIZE IN DRIP IRRIGATION SYSTEM UNDER SEMI-ARID REGION

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SUMMARY

Crop required water for their physiological reactions and growth. Water shortage was the responsible for the yield reduction in maize upto 40 per cent. To investigate the effect of drip irrigation frequency and interval on growth, yield and quality of maize, a field study was conducted during *Kharif* 2019 at Agronomy Research Farm Area, CCS Haryana agricultural university, Hisar, Haryana (India) to determine the effect of drip irrigation on yield and quality maize fodder under semi-arid region of India. The Research Area is located at $29^0 10^{'}$ N latitude and $75^0 46^{'}$ E longitude at an elevation of 215.2 m above mean sea level in North-West part of India. the experiment was conducted with seven treatments *viz*. irrigation every day 100 % of Pen evaporation (T_1), irrigation every day 80 % of Pen evaporation (T_2), irrigation at two days interval 100 % of Pen evaporation (T_3), irrigation at two days interval 80 % of Pen evaporation(T_4), irrigation at four days interval 100 % of Pen evaporation (T_5) irrigation at four days interval 80 % of Pen evaporation (T_6) and Control-Flood irrigation (T_7) in thrice replication with RBD. The objective of research was to find out the effect of drip irrigation on maize fodder yield and quality of fodder. Growth parameter and yield attributes were recorded randomly selected and tagged plant. GFY and DFY under drip irrigation at two days interval 80 % of Pen (I_4) on par with drip irrigation every day 80 % of PEN (I_2). I_1, I_2 and I_3 treatment produced 8.43, 4.08 and 2.08 % more GFY and 8.48, 4.15 and 2.13 % DFY over to I_4 treatment. The flood irrigation (I_7) and drip irrigation every day 100 % of PEN (I_1), drip irrigation every day 80 % of PEN (I_2), drip irrigation at two days interval 100 % of PEN (I_3) were at par in respect to crude protein content.

Key words : Maize, drip irrigation, fodder yield, IVDMD, crude protein content

Water availability is a prerequisite for the sustainable agriculture in the Mediterranean region, which is characterized by water scarcity and extreme events of droughts and floods. The efficient use of water by modern irrigation systems is becoming increasingly important in arid and semi-arid regions with limited water resources. Under water scarcity, both maize yield as well as quality is affected. The demand for fresh and processed food maize is increasing day-by-day, with the challenge of higher water productivity. Drip irrigation has increasingly applied in maize (*Zea mays* L.) production in sub-humid regions (Shweta *et al*., 2020). The effective supply of water and nutrients to plants through drip irrigation not only save the water but also increase the crop yield (Deshmukh and Hardaha, 2014). Decreasing the availability of freshwater resources is one of the major challenges of food and fodder production in many parts of the world. In many agricultural regions, the availability and quality of irrigation water are on the decline due to climate change and growing water demand of other users (e.g., industry, environment, drinking water supply, recreation, mining, etc.). Irrigation water is becoming an increasingly limited resource in many parts of world.

Maize accounts for 18% cereal acreage, 25% productivity and 28% production of world. India ranks sixth in production and fourth in area. Maize (*Zea mays* L.) is one of the most important crops for human and animal consumption and is grown for both grain and silage (Arya *et al.,* 2015 & 2020). It is now increasingly being used for the production of bioethanol. Maize is also cultivated for some special purpose is called speciality maize *viz*., sweet corn,

baby corn and popcorn besides for grain and fodder purpose (Kumar *et al*., 2020). Maize also serves as raw material to industrial products like starch, oil, protein, alcoholic beverages, food, textile, gum, package paper industries etc. Every part of the maize plant has economic value: the grain, leaves, stalk, tassel and cob are used in variety of food and non food products. Maize is very versatile crop grown in Tropical, subtropical and temperate regions. It can be grown with wider diversity of soil, climate, biodiversity and contributing 37 per cent in global production (Anonymous, 2019). In India maize covered 9.9 mha area with 30 mt production during 2020 (Anonymous, 2021). The most important use and demand driver of maize is poultry and cattle feed which accounts 63% of total maize consumption and nearly 8 per cent of maize are consumed by humans. Maize fodder is also in high demand as it is free from anti-metabolites (Kumar *et al*., 2022). Maize is less water requiring with higher water productivity than the rice crop and have the potential to increase area along with production. The present study was undertaken to determine the effect of drip irrigation on maize yield and quality under semi-arid region of India. Generally, irrigation frequency and water application methods play an important role to achieve the full yield potential of food and fodder crop. Hence, it become essential to give more concern over scheduling of irrigation, which will help to achieve the higher productivity, optimum use of water with better irrigation efficiency particularly for crop like maize.

MATERIALS AND METHODS

The experiment was conducted during the *kharif* season of 2019, at Agronomy Research Farm Area, CCS Haryana agricultural university, Hisar, Haryana (India).The research Area is located at $29^{0}10^{'}$ N latitude and $75^{0}46^{'}$ E longitude at an elevation of 215.2 m above mean sea label in north-west part of India. Before sowing the crop, a composite sample of soil was collected for analysis. The soil of experimental site was sandy loam in texture, pH having 7.8, organic carbon content 0.46 % (low), Available nitrogen low (145.7 kg/ha), available phosphorus (14.6 kg/ha) and potassium (270.3 kg/ha) are medium. Maize variety HM-10 was sown on July 25, 2019 after pre-sowing irrigation. Half dose of nitrogen was applied at the time of sowing and 1/3 at knee high stage and 1/3 before tasseling. The sowing was done manually on the raised bed at row to row spacing 75 cm and plant to plant spacing maintained at 25 cm. On each bed, two drip lateral line placed, near to maize line. Irrigation through drip is given according to treatments and in control (flood irrigation) treatment irrigation given to crop as per package *i.e.* six leaf stage, knee high stage, before tasseling and at grain development stages. the experiment was laid down with seven treatments *viz*. irrigation every day 100 % of Pen evaporation (T_1), irrigation every day 80 % of Pen evaporation(T_2), irrigation at two days interval 100% of Pen evaporation (T_3), irrigation at two days interval 80% of Pen evaporation (T_4), irrigation at four days interval 100% of Pen evaporation (T_5), irrigation at four days interval 80% of Pen evaporation (T_6) and Control-Flood irrigation (T_7) in three replications under RBD. The objective of research was to find out the effect of drip irrigation on yield and quality of fodder maize.

RESULTS AND DISCUSSION

Fodder yield parameters, yield and quality

Yield parameters : The data in Table 1 revealed that plant height had significant difference between the irrigation treatments at harvest. Significantly higher plant height was recorded under control (flood irrigation) over to all drip irrigation treatments, while when comparison done between drip irrigation observed that irrigation every day 100% of PEN through drip gave higher plant height and at par with irrigation every day 80% of PEN, irrigation at two days interval 100% of PEN and irrigation at two days interval 80% of PEN. Better growth attributes with increased irrigation levels also reported by Bharti *et al*., 2007, Patil *et al*., 2012 and Basva Sharana 2012. Drip irrigation had significantly affected the plant height and number of leaves. Significantly higher number of leaves was recorded under flood irrigation (15), at par with drip irrigation every day 100 % of PEN (14). This might be due to better growth during early phase of vegetative growth and development. Plant height correlates with plant biomass, so can be used to estimating fodder yield (Han *et al*., 2019 and Kumbar *et al*., 2020).

Fodder yield : Data revealed that green fodder yield of maize ranged from 100 to 125.7 q/ha (Table 1). GFY significantly increased with increasing irrigation frequency and quantity. Maximum GFY was observed in control (125.7 q/ha) *i.e.* flood irrigation, which was at par with drip irrigation every day 100%

TABLE 1
Effect of drip irrigation treatments on yield attributes and yields of maize

Treatments	Plant height (cm)	No of leaves/ plant	Green fodder yield (q/ha)	Dry fodder yield (q/ha)
Irrigation every day 100% of PEN	205.0	14.00	119.7	29.56
Irrigation every day 80% of PEN	199.5	11.33	114.9	28.38
Irrigation at two days interval 100% of PEN	191.0	12.33	112.7	27.83
Irrigation at two days interval 80% of PEN	186.0	10.33	110.4	27.25
Irrigation at four days interval 100% of PEN	153.5	11.33	104.3	25.77
Irrigation at four days interval 80% of PEN	147.0	11.00	100.0	24.69
Control	256.5	15.00	125.7	31.04
C. D. (p =0.05)	27.8	2.37	6.4	1.58

TABLE 2
Effect of drip irrigation treatments on quality of maize fodder

Treatments	Crude protein (%)	IVDMD (%)	Crude protein yield (q/ha)	Digestible dry matter yield (q/ha)
Irrigation every day 100% of PEN	11.56	67.66	3.42	20.00
Irrigation every day 80% of PEN	11.49	62.48	3.25	17.73
Irrigation at two days interval 100% of PEN	11.22	61.90	3.12	17.23
Irrigation at two days interval 80% of PEN	11.00	61.63	3.0	16.80
Irrigation at four days interval 100% of PEN	10.76	59.56	2.77	15.35
Irrigation at four days interval 80% of PEN	10.54	59.01	2.60	14.57
Control	11.64	70.60	3.62	21.91
C. D. (p =0.05)	0.57	4.62	0.30	1.98

of PEN. The increased GFY was mainly due to adequate moisture availability and increased nutrients uptake throughout the crop growth stages, having beneficial effect on yield contributing factors. These findings were also supported by Shivakumar *et al*., (2011). Maintenance of adequate moisture by irrigation established significantly higher DFY (31.04 q/ha) and green fodder yield (125.7 q/ha) in control, *i.e*. flood irrigation over rest of the treatments and was followed by drip irrigation every day 100 % of PEN. Increased the irrigation interval reduces the GFY as well as DFY up to 100.0 and 24.69 q/ha, respectively, in drip irrigation at four days interval 80 % of PEN. This might be due to crop become under stress. Comparison among drip irrigation treatments revealed that GFY and DFY under drip irrigation at two days interval 80% of Pen (I_4) on par with drip irrigation every day 80% of PEN (I_2). I_1, I_2 and I_3 treatment produced 8.43, 4.08 and 2.08 % more GFY and 8.48, 4.15 and 2.13% DFY over to I_4 treatment.

Crude protein content and yield : Fodder digestibility is related with changes in chemical composition and upto great extent with crude protein. Fodders that contain high crude protein are good in quality. At harvest stage crude protein content in leaves significantly decreased with increasing water stress (Table 2).The flood irrigation(I_7) possessed higher crude protein content (11.64 %) than to drip irrigation at four days interval 80 % of PEN (I_6).The flood irrigation (I_7) and drip irrigation every day 100 % of PEN(I_1), drip irrigation every day 80 % of PEN(I_2), drip irrigation at two days interval 100 % of PEN (I_3) were at par in respect to crude protein content. Keskin *et al*., (2005) also reported the reduction in crude protein content under moisture stress and delayed harvesting conditions. Similar finding were also reported by Tokas *et al*., (2021) and Rafi *et al*., (2021).

***In vitro* dry matter digestibility :** IVDMD (%) of Maize fodder ranged from 59.01 to 70.60 % (Table 2). The significantly higher IVDMD (70.60 %) was observed in flood irrigation (T_7) over to all drip irrigation treatments except drip irrigation every day 100 % of PEN (67.66 %). However there was a reduction in IVDMD, with increasing the water stress. In general, IVDMD and crude protein reduced under stress condition.

Crude protein yield : The range of estimated crude protein yield was 2.66 to 3.62 q/ha (Table 2). CPY directly related to DMY and crude protein content (%). Prolonged water stress reduced the CPY.

Digestible dry matter yield : The effect of irrigations treatments on digestible dry matter yield (DDMY) was significant. The range of estimated DDMY from 14.57 to 21.91 q/ha was under different irrigation treatments. The maximum DDMY (21.91 q/ha) was estimated in flood irrigation, which was significantly higher. The minimum DDMY (14.57 q/ha) was estimated under drip irrigation at four days interval 80% of PEN which might be due to the low ADL content under no water stress.

CONCLUSION

Maize growth, green fodder yield, dry fodder yield under drip irrigation at two days interval 80% of PEN was similar to drip irrigation every day 100% of PEN. Drip irrigation can be adopted in maize during *kharif* season with 80 % of PEN at every two days interval which gave statistically equal to drip irrigation every day 100 % of PEN.

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