Enhancing water use efficiency and water productivity of maize-onion cropping system

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 Received: 12.08.2021/Accepted: 31.08.2021

ABSTRACT

Maize is the third most important grain crop in India after rice and wheat with respect to area and productivity. Water is increasingly becoming a major limiting factor for agriculture and hence efficient utilization of available water resources is most important. Drip irrigation system has substantially high irrigation efficiency as compared to surface irrigation method. In order to increase the water use efficiency and water productivity in a single crop, system basis is more important. Present study was conducted during the year 2017-18 at Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu for enhancing the water use and water productivity under maize-onion cropping system. The experimental trial was laid out in randomized block design with four replications. Maize crop was raised during kharif season and onion crop during rabi season. Treatments imposed were drip fertigation @ 50, 75, 100 and 125 per cent pan evaporation and conventional method of irrigation. The results revealed that drip fertigation methods performed better than conventional method of irrigation in maize-onion cropping system. Drip fertigation at 125 per cent pan evaporation regime in maize and onion crops recorded higher grain and bulb yield with a water saving of 29.3 and 28.8 per cent respectively as compared to conventional irrigation method. In both the crops drip fertigation at 100 per cent pan evaporation registered higher water use efficiency and water productivity. Higher net return (Rs 2,48,937) and B-C ratio (3.52) were registered in drip fertigation at 125 per cent pan evaporation followed by drip fertigation at 100 per cent pan evaporation regime.

Keywords: Cropping system; drip irrigation; maize; onion; water use efficiency

INTRODUCTION

Maize is popularly known as corn and is one of the most versatile emerging cash crops having wider adaptability under varied climatic conditions. It is the third most important grain crop in India after rice and wheat with respect to area and productivity. In Tamil Nadu, maize is cultivated under irrigated condition during kharif season in Perambalur, Salem, Cuddalore, Erode, Villupuram and Ariyalur districts. Maize crop is mostly cultivated under ridges and furrows method by adopting surface irrigation method. Water is increasingly becoming a major limiting factor for agriculture in Tamil Nadu and hence efficient utilization of available water resources is most important. Irrigation systems are selected based on their water use efficiency which varies with the soil properties and crop characteristics rather than application system itself. Drip irrigation system has substantially high irrigation efficiency (80 to 90%) as compared to surface irrigation method (Ramulu et al 2010). Drip irrigation is a form of irrigation that saves water and fertilizer by allowing water to drip slowly to the roots of plants either on to the soil surface or directly on to the root zone. Precise application of water is more important with the concept of more crop per drop of water. In order to increase the water use efficiency and water productivity in maize grown districts during kharif season in Tamil Nadu it can be cultivated under raised bed system by using drip irrigation method. Maize is nutrient-exhaustive crop and hence application of fertilizer in right time, right quantity and right stage is more important. It should be easily addressed by adopting the drip irrigation system (Kadasiddappa and Rao 2018). Cropping system represents cropping pattern used on a farm and its interaction with farm resources. In order to increase the water use efficiency and water productivity in a system basis is more

important. In Perambalur, Salem, Cuddalore, Erode, Villupuram and Ariyalur districts of Tamil Nadu maize crop is cultivated under irrigated condition during kharif season. In these districts high value prevailing vegetable crops can be grown during rabi season. Nowadays vegetable crops viz onion and tomato are fetching higher monetary returns. In sandy loam soil condition mostly onion is cultivated during rabi season in above mentioned districts of Tamil Nadu. Hence drip irrigation system is most suitable for precise use of water and fertilizer and increasing water use efficiency and water productivity in system basis.

MATERIAL and METHODS

The field experiment was conducted at Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu during the year 2017-18 in randomized block design with four replications. The soil of the experimental field was clay loam in texture with pH of 8.12, EC of 0.56 ds/m and organic carbon content of 0.42 per cent. The treatments imposed were drip fertigation @ 50 per cent pan evaporation (T_1), drip fertigation @ 75 per cent pan evaporation (T_2), drip fertigation @ 100 per cent pan evaporation (T_3), drip fertigation @ 125 per cent pan evaporation (T_4) and conventional method of irrigation (T_5). Maize crop was raised during kharif season and onion during rabi season. Maize variety chosen for the study was CO H(M) 6 and onion CO (On) 5. For drip irrigation treatments, drip system was installed in raised bed (width of 90 cm) and the distance between two laterals was 120 cm with the water discharge rate of emitters 4 lph. In conventional method, ridges and furrows were formed with a spacing of 60 cm. Irrigation was given once in 3 days through drip system as per the pan evaporation value for the treatment. For conventional method, irrigation was given once in 7-10 days depending upon the soil moisture condition. The effective rainfall amount was added along with irrigation water for the calculation of total water applied in each treatment. The recommended fertilizer schedule for hybrid maize was 250:75:75 kg NPK/ha. For drip irrigation treatments, phosphorus source was single super phosphate which was applied fully as basal whereas N and K (urea and white potash) were applied in split through drip irrigation as per schedule. All the recorded data were analysed statistically as per the method suggested by Gomez and Gomez (1984).

RESULTS and DISCUSSION

Yield attributes and yield

The growth and yield attributes were recorded higher in drip fertigation at 125 per cent pan evaporation as compared to conventional irrigation method in maize and onion crops (Table 1). In maize, higher cob length (18.6 cm) and cob girth (15.9 cm) were recorded in drip fertigation at 125 per cent pan evaporation.

In onion, higher clump weight (63.8 g) and number of bulbs/clump (4) were recorded in drip fertigation at 125 per cent pan evaporation. Drip fertigation at 125 per cent pan evaporation regime in

Table 1. Influence of irrigation regimes on yield attributes and yield of maize-onion cropping system

Treatment	Maize			Onion		
	Cob length (cm)	Cob girth (cm)	Grain yield (kg/ha)	Clump weight (g/plant)	Number of bulbs/ clump	Bulb yield (kg/ha)
Drip fertigation @ 50% pan evaporation (T_1)	10.2	9.1	3,217	34.5	2	7,562
Drip fertigation @ 75% pan evaporation (T_2)	13.7	11.7	4,894	51.5	3	11,093
Drip fertigation @ 100% pan evaporation (T_3)	17.8	14.3	6,456	63.3	4	15,766
Drip fertigation @ 125% pan evaporation (T_4)	18.6	15.9	6,882	63.8	4	16,337
Conventional method of irrigation (T_5)	16.3	14.1	5,463	48.2	3	11,358
SEd	0.6	0.3	118	1.3	0.1	255
$CD_{0.05}$	1.0	0.8	248	2.8	0.2	521

maize recorded higher grain yield (6,882 kg/ha) and in onion registered higher bulb yield (16,337 kg/ha) as compared to conventional irrigation method.

The higher grain yield obtained under drip irrigation system might be due to water released near the root zone and more nutrient uptake as reported by Ramulu et al (2020).

Water use efficiency and water productivity

Drip fertigation at 125 per cent pan evaporation regime in onion registered higher bulb yield of 16,337 kg/ha with a water saving of 28.8 per cent as compared to conventional irrigation method. Drip fertigation at 100 per cent pan evaporation registered higher water use efficiency in maize (16.7 kg/ha mm) and onion (43.5 kg/ha mm) as compared to surface irrigation method (Table 2). Similar results were reported by Hanumanth et al (2016) who reported higher water productivity under drip irrigation method as compared to surface irrigation method.

Economics

In maize-onion cropping system, higher net income of Rs 2,48,937 and B-C ratio of 3.52 were registered in drip fertigation at 125 per cent pan evaporation followed by drip fertigation at 100 per cent pan evaporation regime (Figs 1, 2).

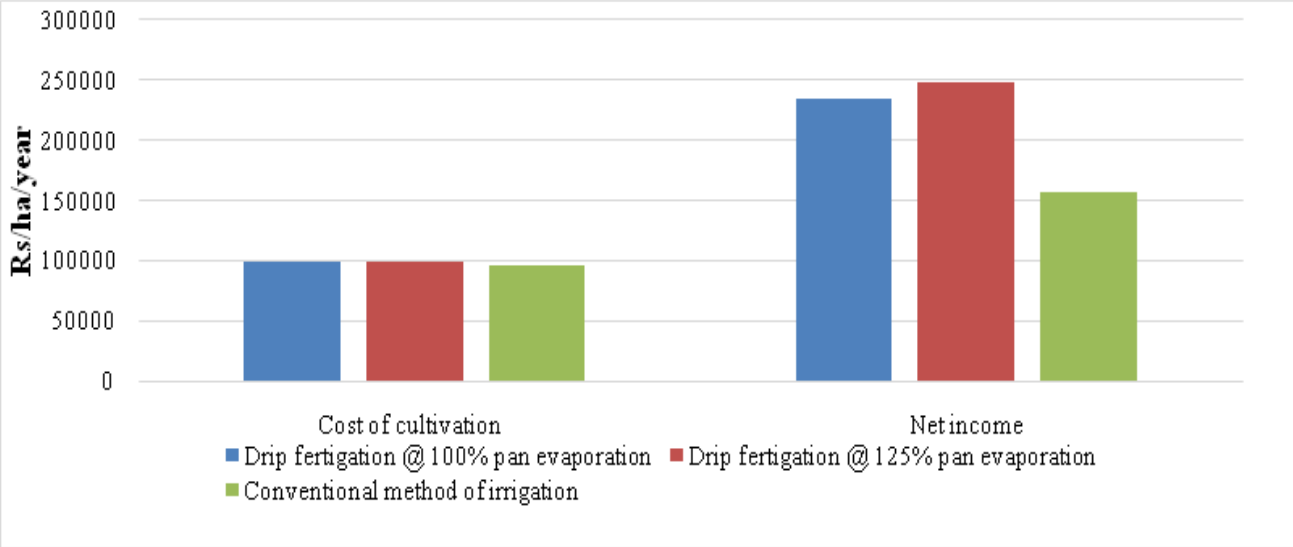

Fig 1. Influence of irrigation regimes on economics of maize-onion on system basis (maize equivalent)

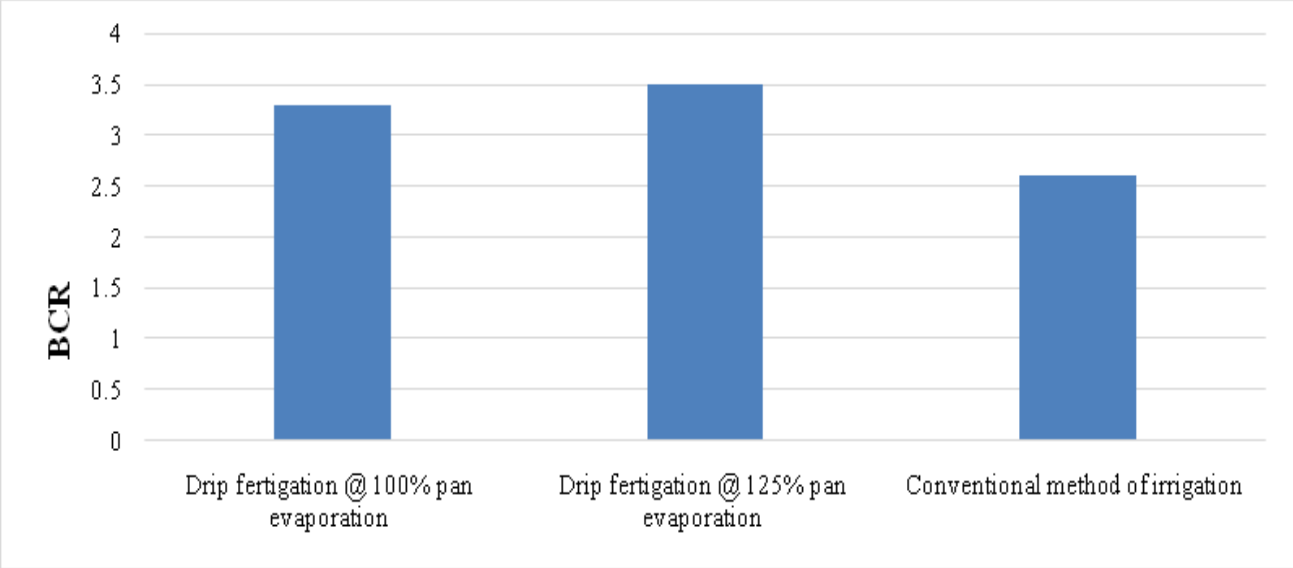

Fig 2. Influence of irrigation regimes on benefit-cost ratio of maize-onion on system basis (maize equivalent)

Table 2. Influence of irrigation regimes on total water use and water use efficiency

Treatment	Maize			Onion		
	Total water used (mm)	WUE (kg/ha mm)	Water productivity (Rs/ha mm)	Total water used (mm)	WUE (kg/ha mm)	Water productivity (Rs/ha mm)
DF @ 50% pan evaporation	205	15.6	162.7	194	38.9	327.2
DF @ 75% pan evaporation (T_2)	312	15.7	204.6	284	39.1	442.1
DF @ 100% pan evaporation (T_3)	388	16.7	249.6	362	43.5	653.3
DF @ 125% pan evaporation (T_4)	416	16.5	248.1	412	39.6	594.8
Conventional Method	588	9.3	139.8	578	19.6	294.7

DF= Drip fertigation, WUE= Water use efficiency

CONCLUSION

Drip fertigation methods performed better than conventional irrigation method in maize-onion cropping system. Drip fertigation at 125 per cent pan evaporation regime recorded higher yield with a water saving of 29.3 and 28.8 per cent respectively. The net return and B-C ratio were also registered higher under drip fertigation at 125 per cent followed by drip fertigation at 100 per cent pan evaporation regime. Drip fertigation at 100 per cent pan evaporation registered higher water use efficiency in maize-onion system as compared to surface irrigation method.

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