Performance Evaluation of Fertigation of N and K on Yield and Water Use Efficiency of Turmeric through Drip Irrigation

G. Thiyagarajan[1]*, M. Vijayakumar[1], P. K. Selvaraj[2], V. K. Duraisamy[1] and M. Mohamed Yassin[1]

[1]Agricultural Research Station, Tamil Nadu Agricultural University, Bhavanisagar, Tamil Nadu (638 451), India
[2]Agricultural College and Research Institute, Trichy, Tamil Nadu, India

Article History

Manuscript No. 71
Received in 27th September, 2010
Received in revised form 21st January, 2011
Accepted in final form 1st March, 2011

Correspondence to

E-mail: thiyagu_1977@rediffmail.com

Keywords

Turmeric, water use efficiency, drip irrigation, yield

Abstract

Field experiments were conducted at Agricultural Research Station, Tamil Nadu Agricultural University, Bhavanisagar (India) during 2004-05 and 2005-06 to study the effect of drip irrigation and N and K fertigation on the yield and water use efficiency of turmeric. The results revealed that drip irrigation at 80 and 60% of PE once in 2 days and fertigation levels of 125, 100 and 75% of N and K produced higher yields (32.9 to 41.96) t ha^{-1} during first and second crop) which were superior over other levels of irrigation. Irrigation water saving of 34 and 46% during 2004-05 and 21 and 34% during 2005-06, respectively were recorded in drip irrigation at 80 and 60% PE. Water use efficiency in drip irrigation treatments were 51.34, 56.85 and 62.70 kg ha^{-1} mm^{-1} during 2004-05 with 40, 45 and 47% during 2005-06 in drip irrigation at 80, 60 and 40% PE once in 2 days, respectively as compared to 25.11 and 22.00 kg ha^{-1} mm^{-1} in surface irrigation with increased B/C ratio of 3.69 to 4.16. Irrigating at 60% PE will produce profitable yield as compared to other treatments.

1. Introduction

Turmeric (*Curcuma longa* L.) is one of the most important rhizomatous crop with a production of 1,99,000 t from an area of 99,000 ha in Andhra Pradesh, Orrisa, Tamil Nadu, Bihar and Kerala states of India. Turmeric requires assured water supply almost throughout the year (8 to 9 months). Recently, emerging water scarcity demands the introduction of water saving methods to avoid reduction in turmeric area. When N and K fertilizers are applied through drip, there may be possibilities of reduction in cost of application and quantity of fertilizers, which will reduce the cost of input without reduction in productivity. Drip irrigation considered as one of the latest innovative methods of irrigation, which enables slow and precise application of water and nutrients to precise locations, avoiding soil erosion and wastage of water by deep percolation (Herman, 1982). Drip irrigation is now being used in crops such as sugarcane, vegetables, cassava, sugar beet, mulberry, cotton, etc. in water scarcity areas. There can be considerable saving of irrigation water by adopting drip method since water can be almost applied precisely and directly in the root zone without wetting the entire surface area (Bafna et al., 1993; Ahlwaalia et al., 1993). The minimum water loss and higher yield $unit^{-1}$ of water was possible only if water application methods like sprinkler and drip were adopted (Patel et al., 1994). According to Adhate (1958), about 150-165 cm of water is required to produce a good crop of turmeric. Drip irrigation was found to reduce this water requirement of turmeric by 20-60% in Tamil Nadu and Maharashtra (Selvaraj et al., 1997; Singandhupe and Brahmanand, 2000). Hence, the present investigation was carried out on irrigation schedule on the yield and water use efficiency of turmeric through drip irrigation.

2. Materials and Methods

Field experiment was conducted to study the effect of fertigation through drip on the yield of turmeric in comparison with surface irrigation and soil application along with the optimization of N and K requirements through fertigation during 2004-05 and 2005-06 at Agricultural Research Station, Tamil Nadu Agricultural University, Bhavanisagar, Tamil Nadu, India. The soil of the experimental field was sandy loam with a pH of 8.1 and electrical conductivity of 0.18 dSm^{-1}. The infiltration rate of soil was 2.1 cm h^{-1}, field capacity 21.8%, permanent wilting point 10.8%, bulk density 1.38 mg m^{-3} and the organic content was 0.32%. The nutritional status of the soil was low in available nitrogen (223 kg ha^{-1}) and available phosphorus (9.8 kg ha^{-1}) and medium in available potassium (181 kg ha^{-1}). The

experiment comprising of ten treatments, viz. surface irrigation, 5 cm at 0.90 IW/CPE ratio with 100% recommended N and K (T_1), drip once in 2 days with 125, 100, 75% of recommended N and K fertilizers at 80% pan evaporation (PE) (T_2, T_3, T_4), at 60% PE (T_5, T_6, T_7) and at 40% PE (T_8, T_9, T_{10}), respectively was laid out in randomized block design with three replications. Laterals of 12 mm diameter were laid at 1 m spacing for each pair of rows and drippers of 4 l h^{-1} were fixed at 60 cm interval along the laterals. Fertigation of N and K was given in 20 splits from 5th to 24th week after sowing. The turmeric variety BSR-1 was dibbled with the spacing of 15 cm along the rows and 50 cm between the rows for surface irrigation and 15 cm spacing only in the paired row (40 cm between rows and 60 cm between pairs of rows) in drip irrigation treatments with the seed rate of 2000 kg ha^{-1} of rhizomes were planted on June 30, 2004 and July 21, 2005. The crop was raised with all recommended package of practices except the irrigation and fertilizer application.

3. Results and Discussion

3.1. Effect of irrigation and fertigation on crop yield

The irrigation methods had significant variation on the crop yield in both the years. The treatments of drip irrigation once in two days at 80, 60 and 40% of PE along with fertigation levels of 125, 100 and 75% of N and K produced higher yields (34.31 to 41.96 t ha^{-1} during 2004-05 and 32.90 to 34.76 t ha^{-1} during 2005-06) and were superior over surface irrigation (28.12 and 22.50 t ha^{-1}) (Table 1) in 2004-05 and 2005-06 years, respectively. From these results it can be understood that 75% of recommended N and K can produce comparable yield with 125 and 100% of recommended N and K, hence a saving of 25% of recommended N and K can be achieved through drip fertigation which might be possibly due to the accurate and uniform application along with the amount and concentration of specific nutrients that can be adjusted depending on the crop need (Bar-Yosef and Shelkholslami, 1982; Dangler and Lacascio, 1990; Fontes et al., 2000).

3.2. Effect of irrigation and fertigation on water use efficiency and irrigation water saving

Irrigation water saving of 34, 21 and 34, 46% during 2004-05 were recorded in drip irrigation at 80 and 60% PE, respectively. The water use efficiencies in drip irrigation treatments were 51.34, 56.85 and 62.70 kg ha^{-1} mm^{-1} during 2004-05, and 40, 45 and 47 kg ha^{-1} mm^{-1} during 2005-06 in drip irrigation at 80, 60 and 40% PE once in 2 days, respectively (Table 2) as compared to 25.11 and 22.00 kg ha^{-1} mm^{-1} in surface irrigation treatment. The results reported by Selvaraj et al. (1997) also registered highest water use efficiency in the treatment irrigating with drip at 0.36 IW/CPE ratio daily with highest yield.

3.3. Economics of irrigation and fertigation

The economic evaluation of the results revealed that the net returns and gross returns were higher under drip irrigation treatments compared with that of surface irrigation (Table 3).

Table 1: Effect of drip fertigation on economic crop yield (t ha^{-1}) of fresh turmeric rhizomes

Treatments	2004-05 (t ha^{-1})	2005-06 (t ha^{-1})
T_1	28.12	22.50
T_2	38.46	32.91
T_3	41.32	34.76
T_4	41.96	33.62
T_5	38.16	33.26
T_6	37.47	33.69
T_7	40.25	34.12
T_8	36.23	29.70
T_9	34.31	29.98
T_{10}	36.53	29.49
SEd	2.48	1.68
CD (p=0.05)	5.21	3.54

Table 2: Effect of drip fertigation on total water used and water use efficiency in turmeric

Sl. No.	Particulars	T_1 (surface irrigation)		T_2, T_3, T_4 (drip at 80% PE)		T_5, T_6, T_7 (drip at 60% PE)		T_8, T_9, T_{10} (drip at 40% PE)	
1.	Irrigation water applied (mm)	960	820	630.4	648	519.4	545	408.4	437
2.	Irrigation water saving (%)	-	-	34	21	46	34	57	47
3.	Effective rainfall (mm)	160	197	160	197	160	197	160	197
4.	Total water used (mm)	1120	1017	790.4	845	679.4	742	568.4	634
5.	Yield (kg ha^{-1})	28120	22500	40580	33763	38627	33690	35690	29723
6.	Water use efficiency (kg ha^{-1} mm^{-1})	25.11	22	51.34	40	56.85	45	62.70	47
7.	Percent increase in water use efficiency	-	-	104	82	126	105	150	114

Table 3: Economics of drip fertigation in turmeric							
Treatments	Cost of cultivation [(Indian Rupees (₹) ha^{-1})]	2004-05			2005-06		
		Gross returns (₹ ha^{-1})	Net returns (₹ ha^{-1})	B:C ratio	Gross returns	Net returns (₹ ha^{-1})	B:C ratio
T1	41,250	1,40,600	99,350	3.41	1,12,500	71,250	2.73
T2	51,025	1,92,300	1,41,275	3.77	1,64,550	1,13,525	3.22
T3	50,750	2,06,600	1,55,850	4.07	1,73,800	1,23,050	3.42
T4	50,475	2,09,800	1,59,325	4.16	1,68,100	1,17,625	3.33
T5	51,025	1,90,800	1,39,775	3.74	1,66,300	1,15,275	3.26
T6	50,750	1,87,350	1,36,600	3.69	1,68,450	1,17,700	3.32
T7	50,475	2,01,250	1,50,775	3.99	1,70,600	1,20,125	3.38
T8	51,025	1,81,150	1,30,125	3.55	1,48,500	97,475	2.91
T9	50,750	1,71,550	1,20,800	3.38	1,49,900	99,150	2.95
T10	50,475	1,82,650	1,32,175	3.62	1,47,450	96,975	2.92

The highest net returns and B:C ratio were recorded with the treatments drip once in 2 days at 80, 60, 40% of PE during both the years and recorded the B:C ratios in the range of 3.69 to 4.16 as compared to surface irrigation (3.41).

4. Conclusion

Drip fertigation once in two days at 60% of PE was found to be optimum in enhancing the productivity of turmeric with enhanced water use efficiency and B:C ratio. In future, the irrigation treatments should be fixed with respect to the available moisture content of the soil, which would be more accurate.

5. References

Adhate, S., 1958. Turmeric cultivation practices. Turmeric Farmer 9(12), 21-27.

Ahlwaalia, M.S., Singh, B., Gill, B.S., 1993. Drip irrigation system—its hydraulic performance and influence on tomato and cauliflower crops. Journal of Water Management 1(1), 6-9.

Bafna, A.M., Daftardar, S.Y., Khade, K.K., Patel, P.V., Dhotre, R.S., 1993. Utilization of nitrogen and water by drip irrigation system. Journal of Water Management 1(1), 1-5.

Bar-Yosef and Shelkholslami, M.R., 1982. Distribution of water and ions in soils irrigated and fertilized from a trickle source. Soil Science Society America Proceedings 40, 575-583.

Dangler, J.M., Locascio, S.J., 1990. Yield of trickle-irrigated tomatoes as affected by time of N and K application. Journal of American Society of Horticultural Sciences 115(4), 585-589.

Fontes, P.C.R., Sampaio, R.A., Finger, F.L., 2000. Fruit size, mineral composition and quality of trickle irrigated tomatoes as affected by potassium rates. Pesquisa Agropecuaria Brasileira 35(1), 21-25.

Herman, J.F., 1982. CRC Hand Book of Irrigation Technology, Vol. I. CRC press, Florida.

Patel, P.G., Patel, Z.G., Lad, A.N., 1994. Irrigation scheduling in safflower through mini sprinkler. Journal of Water Management 2 (1&2), 24-26.

Selvaraj, P.K., Krishnamurthi, V.V., Manickasundaram, P., James Martin, G., Ayyaswamy, M., 1997. Effect of irrigation schedules and nitrogen levels on the yield of turmeric through drip irrigation. Madras Agricultural Journal 84, 347-348.

Singandhupe, R.B., Brahmanand, P.S., 2000. Status of fertigation in vegetable, plantation and cash crops: a review. In: International Conference on Micro and Sprinkler Irrigation Systems, February 8-10, Jalgaon, Maharashtra, 84.