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OPTIMISATION OF IRRIGATION AND FERTIGATION LEVELS TO TURMERIC UNDER DIFFERENT DRIP LATERAL SPACING FOR WESTERN ZONE OF TAMIL NADU

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ABSTRACT
Field experiments were conducted at Agricultural Research Station, Bhavanisagar during 2013-14 to 2015-16 to optimize irrigation and fertigation level to turmeric under different lateral spacing. The experiment was laid out in split plot design with two replications. The experiment comprised of three irrigation levels of 80, 60, 40 per cent pan evaporation at a lateral spacing of 90 cm and four irrigation levels of 120, 100, 80, 60 per cent pan evaporation at a lateral spacing of 150 cm in combination with three fertigation levels of 125, 100 and 75 per cent of recommended N & K. The results of this study revealed that drip irrigation at 40% of PE with lateral spacing of 90 cm recorded lower water use (721 mm) and higher WUE (46.21 kg/ha mm). However, significantly higher and comparable yield of turmeric was recorded in drip irrigation at either 80 or 60% of PE (37.22 and 36.5 t/ha) with lateral spacing of 90 cm and 120% of PE with lateral spacing of 150 cm along with 100% recommended dose of N & K (35 t/ha). Higher net return and B:C ratio were recorded at 80% of PE with lateral spacing of 90 cm with 100 recommended dose of N & K.

INTRODUCTION

Turmeric (*Curcuma longa L.*) is one of the important spices in India with a production of 9.93 lakh tonnes from an area of 1.95 lakh ha (OGD, 2010-11). India is a leading country in the world in terms of turmeric producer, consumer and exporter, accounting for major share of about 78 per cent of world turmeric production and 60 per cent of the global trade (Angles *et al.,* 2011). The important turmeric growing states in India are Andhra Pradesh, Tamil Nadu, Orissa, Maharastra, Assam, Kerala, Karnataka and West Bengal.

In Tamil Nadu major turmeric sown districts are Vellore, Namakkal, Erode and Coimbatore (Thavaprakaash *et al.,* 2008). Western zone farmers of Tamil Nadu are more interested to cultivate turmeric crop due to high market value and export opportunities. Well established regulated market with canal water supply and sandy clay loam soils with good fertility also favoured the farmers to cultivate turmeric crop.

Increasing yield, dry matter production and quality of produces can be achieved if crops are grown with drip feritigation (Sharma *et al.,* 2013, Ughade and Mahadkar, 2015). Introduction of drip fertigation increases the yield of crops by 3 times and saving of fertilizer by 30 per cent (Sivanappan and Ranghaswami, 2005). Also turmeric is a highly input responsive crop (Satyareddi and Angadi, 2014). It responds well to increased soil fertility levels (Subramanian *et al.*, 2001). Studies showed that sufficient amount of nutrients and irrigation produced higher yields with improved quality (Parthasarathy *et al.,* 2010).

Farmers normally opt the lateral spacing of drip irrigation either 150 or 90 cm for cultivating agricultural/horticultural crops. Water savings are usually achieved by reducing the irrigation hours irrespective of lateral spacing. In the common drip lay out of 150 cm lateral spacing which is being recommended for most of the crops, turmeric is cultivated in such a way that four rows are recommended in one lateral. The lateral spacing of 90 cm for turmeric which covers two rows, though high cost and water application, can be adopted by some farmers. Farmers who adopted 150 cm spacing raised the problem of excess water usage for wetting the four rows i.e. over irrigation in the two rows near to lateral and problem of rhizome rot in these two rows. Moreover farmers are also having the opinion that more of fertilizers are leached away from root zone in this 150 cm spacing in turmeric crop. Very limited research work has been carried to optimize irrigation and fertilizer levels for turmeric. However, no study has been carried out previously to optimize such irrigation and fertigation levels under different lateral spacing for western zone farmers of Tamil Nadu. Hence this study was envisaged to optimize the irrigation and fertigation levels for turmeric through drip irrigation for sandy loam soils of western zone, besides fixing correct lateral spacing to avoid fertilizer and water loss.

MATERIALS AND METHODS

Field experiment was conducted to optimize irrigation and fertigation level to turmeric under different lateral spacing during 2013-14, 2014-15 and 2015-16 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 7.5 and electrical conductivity of 0.26 dS/m. The infiltration rate of soil was 1.85 cm/hr, field capacity 23.1%, permanent wilting point 12.5%, bulk density 1.48 mg/m^3 and the organic carbon content was 0.26%. The nutritional status of the soil was low in available nitrogen (286 kg/ha) and available phosphorus (18 kg/ha) and medium in available potassium (390 kg/ha).

The experiment consist of seven irrigation levels viz. drip irrigation at 80, 60 and 40 % of pan evaporation (PE) with lateral spacing of 90 cm (I_1, I_2, I_3) and drip irrigation at 120, 100, 80 and 60% of PE with lateral spacing of 150 cm (I_4, I_5, I_6, I_7) with three fertigation levels of 125, 100 and 75% of recommended N & K (F_1, F_2, F_3) was laid out in split plot design with two replications. 100% recommended dose of fertilizers for turmeric is 150:60:108 NPK kg/ha. Turmeric variety used in this study was BSR2 with the seed rate of 2000 kg/ha of rhizomes. Turmeric rhizomes were sown in the bed and covering with soil.

Drip irrigation system was laid out with a lateral spacing of 150 and 90 cm as per treatments and drippers spacing of 0.5 m (inline laterals) with a dripper discharge of 4 lph. Turmeric rhizomes were sown at 35 cm between rows, 4 rows in a bed of 120 cm, 15 cm between plants. One lateral of 150cm spacing covers 4 rows of plants. For 90 cm lateral spacing rhizome were sown at 40 cm between rows, 2 rows in a bed of 60 cm, 15 cm between plants. One lateral covers 2 rows of plants. Treatmental irrigations were given once in three days as per the treatments. Entire Phosphorus (P) was applied in single dose as basal. Nitrogen (N) and Potassium (K) were applied through fertigation in drip system once in 6 days in 22 splits starting from 5th week to 26th week after sowing as per treatments.

The first crop trial was initiated on 24-06-2013 and completed on 05-02-2014. Second year crop trial was initiated on 12-06-2014 and completed on 17-03-2015. Confirmation trial was initiated on 17-06-2015 and completed on 08-03-2016. The crop was raised with all recommended package of practices except the irrigation and fertilizer application. Treatment wise turmeric yield was recorded and total water used, water use efficiency and economics were worked out and presented here.

RESULTS AND DISCUSSION

Effect of irrigation and fertigation on total water used and water use efficiency

Different drip irrigation levels exerted significant difference on WUE of turmeric (Table 1). WUE was higher under drip irrigation treatments with the lateral spacing of 90 cm compared to drip irrigation treatments with the lateral spacing of 150 cm. Among the different irrigation levels, drip irrigation at 40% of PE with lateral spacing of 90 cm (I_3) recorded lower water use (734, 797 and 632 mm) and higher WUE in all three crops (43.28, 49.31 and 46.04 kg/ha mm). It is followed by drip irrigation 60% of PE with lateral spacing of 90 cm (I_2). The increase in WUE in all drip irrigation treatments with the lateral spacing of 90 cm over 150 cm lateral spacing was mainly due to considerable saving of irrigation water, greater increase in yield of crops. The treatments I_4 to I_7 recorded lower water use efficiencies because of increased water use due to increased lateral spacing of 150 cm. The results reported by Selvaraj *et al*. (1997) also registered higher water use efficiency in the treatment irrigating with drip at 0.36 IW/CPE ratio daily with highest yield. Thiyagarajan *et al*. (2011) reported the higher

Table 1: Effect of different irrigation levels at different lateral spacing on total water used and WUE for turmeric

Treatment	2013-14 Total water used (mm)	WUE (kg/ha mm)	2014-15 Total water used (mm)	WUE (kg/ha mm)	2015-16 Total water used (mm)	WUE (kg/ha mm)
I_1 (90cm, 0.8PE)	1,069	31.44	1,169	38.37	863	38.46
I_2 (90cm, 0.6PE)	902	37.04	982	44.52	747	43.29
I_3 (90cm, 0.4PE)	734	43.28	797	49.31	632	46.04
I_4 (150cm, 1.2PE)	1,467	22.69	1,567	26.34	1,102	27.73
I_5 (150cm, 1.0PE)	1,299	23.85	1,406	27.67	986	29.20
I_6 (150cm, 0.8PE)	1,132	23.84	1,215	29.43	870	32.03
I_7 (150cm, 0.6PE)	974	23.74	1,033	34.61	757	34.97

Table 2: Effect of irrigation and fertigation at different lateral spacing on crop yield for turmeric

Treatment	2013-14				2014-15				2015-16				Pooled data			
	F_1	F_2	F_3	Mean	F_1	F_2	F_3	Mean	F_1	F_2	F_3	Mean	F_1	F_2	F_3	Mean
I_1 (90cm, 0.8PE)	33.70	35.06	32.10	33.62	41.60	49.51	43.46	44.86	30.79	36.63	32.16	33.19	35.37	40.40	35.90	37.22
I_2 (90cm, 0.6PE)	33.33	35.80	31.11	33.42	42.65	46.48	42.04	43.72	31.56	34.40	31.11	32.36	35.85	38.89	34.75	36.50
I_3 (90cm, 0.4PE)	31.85	33.46	30.00	31.77	39.26	40.80	37.84	39.30	29.05	30.19	28.00	29.08	33.39	34.82	31.95	33.38
I_4 (150cm, 1.2PE)	34.81	33.46	31.60	33.29	40.49	44.26	39.07	41.28	29.97	32.75	28.91	30.54	35.09	36.82	33.20	35.04
I_5 (150cm, 1.0PE)	32.72	30.99	29.26	30.99	39.07	41.30	36.36	38.91	28.91	30.56	26.90	28.79	33.57	34.28	30.84	32.90
I_6 (150cm, 0.8PE)	28.40	26.79	25.80	27.00	36.79	39.57	36.67	37.67	27.22	29.28	27.13	27.88	30.80	31.88	29.87	30.85
I_7 (15ocm, 0.6PE)	24.44	23.09	21.85	23.13	34.44	38.21	34.63	35.76	25.49	28.28	25.63	26.46	28.13	29.86	27.37	28.45
Mean	31.32	31.23	28.82	39.19	42.87	38.58		29.00	31.73	28.55		33.17	35.28	31.98		
	I	F	I at F	F at I	I	F	I at F	F at I	I	F	I at F	F at I	I	F	I at F	F at I
S.Ed.	0.2	0.1	0.29	0.26	1.44	1.17	3.06	3.31	1.07	0.87	2.26	2.45	0.87	0.7	1.84	1.98
CD (p = 0.05)	0.44	0.2	0.61	0.52	3.14	2.4	6.36	6.77	2.32	1.77	4.7	5.01	1.89	1.44	3.82	4.06

Table 3: Effect of different irrigation and fertigation levels at different lateral spacing on economic for turmeric

Treatment	Cost of Cultivation (Rs/ha)	2013-14 Gross return (Rs)	Net return (Rs)	B:C Ratio	2014-15 Gross return (Rs)	Net return (Rs)	B:C Ratio	2015-16 Gross return (Rs)	Net return (Rs)	B:C Ratio
I_1F_1 (90cm, 0.8PE, 125RDF)	77,000	3,37,037	2,60,037	3.4	4,16,049	3,39,049	4.4	4,24,380	3,47,380	4.5
I_1F_2 (90cm, 0.8PE, 100RDF)	75,000	3,50,617	2,75,617	3.7	4,95,062	4,20,062	5.6	4,84,812	4,09,812	5.5
I_1F_3 (90cm, 0.8PE, 75RDF)	73,000	3,20,988	2,47,988	3.4	4,34,568	3,61,568	5.0	4,30,860	3,57,860	4.9
I_2F_1 (90cm, 0.6PE, 125RDF)	77,000	3,33,333	2,56,333	3.3	4,26,543	3,49,543	4.5	4,30,212	3,53,212	4.6
I_2F_2 (90cm, 0.6PE, 100RDF)	75,000	3,58,025	2,83,025	3.8	4,64,815	3,89,815	5.2	4,66,716	3,91,716	5.2
I_2F_3 (90cm, 0.6PE, 75RDF)	73,000	3,11,111	2,38,111	3.3	4,20,370	3,47,370	4.8	4,17,024	3,44,024	4.7
I_3F_1 (90cm, 0.4PE, 125RDF)	77,000	3,18,519	2,41,519	3.1	3,92,593	3,15,593	4.1	4,00,656	3,23,656	4.2
I_3F_2 (90cm, 0.4PE, 100RDF)	75,000	3,34,568	2,59,568	3.5	4,08,025	3,33,025	4.4	4,17,816	3,42,816	4.6
I_3F_3 (90cm, 0.4PE, 75RDF)	73,000	3,00,000	2,27,000	3.1	3,78,395	3,05,395	4.2	3,83,364	3,10,364	4.3
I_4F_1 (150cm,1.2PE, 125RDF)	72,000	3,48,148	2,76,148	3.8	4,04,938	3,32,938	4.6	4,21,092	3,49,092	4.8
I_4F_2 (150cm,1.2PE, 100RDF)	70,000	3,34,568	2,64,568	3.8	4,42,593	3,72,593	5.3	4,41,876	3,71,876	5.3
I_4F_3 (150cm,1.2PE, 75RDF)	68,000	3,16,049	2,48,049	3.6	3,90,741	3,22,741	4.7	3,98,376	3,30,376	4.9
I_5F_1 (150cm,1.0PE, 125RDF)	72,000	3,27,160	2,55,160	3.5	3,90,741	3,18,741	4.4	4,02,816	3,30,816	4.6
I_5F_2 (150cm,1.0PE, 100RDF)	70,000	3,09,877	2,39,877	3.4	4,12,963	3,42,963	4.9	4,11,372	3,41,372	4.9
I_5F_3 (150cm,1.0PE, 75RDF)	68,000	2,92,593	2,24,593	3.3	3,63,580	2,95,580	4.3	3,70,092	3,02,092	4.4
I_6F_1 (150cm,0.8PE, 125RDF)	72,000	2,83,951	2,11,951	2.9	3,67,901	2,95,901	4.1	3,69,636	2,97,636	4.1
I_6F_2 (150cm,0.8PE, 100RDF)	70,000	2,67,901	1,97,901	2.8	3,95,679	3,25,679	4.7	3,82,548	3,12,548	4.5
I_6F_3 (150cm,0.8PE, 75RDF)	68,000	2,58,025	1,90,025	2.8	3,66,667	2,98,667	4.4	3,58,404	2,90,404	4.3
I_7F_1 (150cm,0.6PE, 125RDF)	72,000	2,44,444	1,72,444	2.4	3,44,444	2,72,444	3.8	3,37,512	2,65,512	3.7
I_7F_2 (150cm,0.6PE, 100RDF)	70,000	2,30,864	1,60,864	2.3	3,82,099	3,12,099	4.5	3,58,284	2,88,284	4.1
I_7F_3 (150cm,0.6PE, 75RDF)	68,000	2,18,519	1,50,519	2.2	3,46,296	2,78,296	4.1	3,28,428	2,60,428	3.8

water use efficiencies in drip irrigation treatments of 80, 60 and 40% PE once in 2 days as compared to surface irrigation treatment.

Effect of irrigation and fertigation on turmeric yield

Irrigation levels at 90 and 150 cm lateral spacing studied in this experiment had made significant variation on the crop yield in all the years. Turmeric rhizome yield was higher under drip irrigation treatments with the lateral spacing of 90 cm compared to drip irrigation treatments with the lateral spacing of 150 cm. During the first year study, among the different irrigation levels, drip irrigation at 80% PE with lateral spacing of 90 cm recorded significantly higher yield (33.62 t/ha) irrespective of fertigation levels. Irrespective of irrigation levels and lateral spacing, 125% recommended doze of N & K through fertigation recorded significantly higher yield (31.32 t/ha) and it is on par with 100% recommended doze of N & K through fertigation. During the second, third year crop and pooled data analaysis, drip irrigation at 80 and 60% of PE with lateral spacing of 90 cm, 120% of PE with lateral spacing of 150 cm, recorded significantly higher and comparable yield. For different fertigation levels, 100% recommended doze of N & K through fertigation recorded significantly higher yield. With regards to interaction, I_1F_2 (90cm, 0.8PE, 100RDF) recorded significantly higher yield for second, third crop and pooled data. It is followed by I_2F_2 (90cm, 0.6PE, 100RDF) and I_4F_1 (150cm, 1.2PE, 125RDF). The reason for getting higher yield in 90 cm lateral spacing when compared to 150 cm lateral spacing might be due minimum crop growth competition, less water stress on both row crops, high water spread across the bed and optimum nutrient uptake. A study on effect of fertigation on growth and yield of turmeric conducted by Sadarunnisa *et al.,* 2010 reported that 100% recommended doze of fertilizers applied through drip recorded the maximum plant height, number of tillers per plant and fresh rhizome yield. Another study in turmeric showed that fertigation with 100 % levels of N and K either through straight fertilizers or through water soluble fertilizers enhances quality and to gain higher returns also (Krishnamoorthy et al., 2015). However Leva et al., 2013 found that fertigation with 120% RD of N and K markedly influenced growth and yield attributes, as well as rhizome yield.

Economics of drip fertigation in Turmeric

The economic evaluation of the results revealed that the net returns and gross returns were higher under drip fertigation treatments with 90cm lateral spacing compared with that of drip fertigation treatments with 150 cm lateral spacing (Table 3). The treatments I_1F_2 (90cm, 0.8PE, 100RDF) recorded the higher net return of Rs. 2,75,617, Rs. 4,20,062 and Rs. 4,09,812/ha and higher B : C ratio of 3.7, 5.6 and 5.6 during the crop period of 2013-14, 2014-15 and 2015-16 respectively. And it was followed by I_4F_2 (150cm,1.2PE, 100RDF) and I_2F_2 (90cm, 0.6PE, 100RDF). The treatments in I_1(90cm,0.8PE), I_2 (90cm,0.6PE), I_3 (90cm,0.4PE), I_4 (150cm,1.2PE), I_5 (150cm,1.0PE) recorded B: C ratios higher than 4.

Turmeric raised at 150 cm lateral spacing has performed equally well with turmeric raised at 90 cm lateral spacing. Moreover yield increase of 90 cm lateral spacing over 150 cm lateral spacing was only 6 per cent. However adoption of 150 cm lateral spacing for getting higher yield may not be feasible from the water saving point of view due to high operating hours for irrigating all four rows of crops. But from the economics point of view 150 cm lateral spacing with 120% PE may be feasible.

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REFERENCES

Angles, S., Sundar, A. and Chinnadurai, M. 2011. Impact of globalization on production and export of turmeric in India - An economic analysis. *Agric. Eco. Res. Rev.* **24:** 301-308.

Krishnamoorthy, C., Soorianathasundaram, K. and Mekala, S. 2015. Effect of fertigation on FUE, quality and economics of cultivation in turmeric (*curcuma longa l*) cv. BSR 2. *International J. Agricultural Science and Research.* **5(1):** 67-72.

Leva, R. L., Thanki, J. D., Patel, D. D. and Patel, T. U. 2013. Effect of different planting methods and levels of fertigation on turmeric (Curcuma longa L.) *BIOINFOLET.* **10(3a):** 811-813.

OGD (Open Government Data) Platform India. Area/ Production and Productivity of various kinds of Spices (Assessed on 07-09-2016)

Parthasarathy, V. A., Dinesh, R., Srinivasan, V. and Hamza, S. 2010. Integrated nutrient management in major spices. *Indian J. Fert.* **6:** 110-128.

Sadarunnisa, S., Madhumathi, C., Srinivasa Rao, G. and Sreenivasulu, B. 2010. Effect of fertigation on growth and yield of turmeric cv. Mydukur. *J. Hortl. Sci.* **5(1):** 78-80.

Satyareddi, S. A. and Angadi, S. S. 2014. Response of turmeric (Curcuma longa L.) varieties to irrigation methods and graded levels of fertilizer. *Res. Environ. Life Sci.* **7(4):** 237-242.

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

Sharma, S., Sanmay Patra, Gokul, B. Roy and Soumen Bera. 2013. Influence of drip irrigation and nitrogen fertigation on yield and water productivity of guava. *The Bioscan.* **8(3):** 783-786.

Sivanappan, R. K. and Ranghaswami, M. V. 2005. Technology to take 100 tons per acre in Sugarcane. *Kissan World.* **32:** 35-38.

Subramanian, K. S., Sivasamy, N. and Thangaraj, T. 2001. Integrated nutrient management for turmeric. *Spice India.* **14(12):** 25-26.

Thavaprakaash, N. C. Babu, C. and Jagannathan, R. 2008. Identifying potential cropping zones for important horticultural crops of Tamil Nadu. *Madras Agric. J.* **95 (7-12):** 418-424.

Thiyagarajan, G., Vijayakumar, M., Selvaraj, P. K., Duraisamy, V. K. and Mohamed Yassin, M. 2011. Performance Evaluation of Fertigation of N and K on Yield and Water Use Efficiency of Turmeric through Drip Irrigation. *International J. Bio. stress. Management.* **2(1):** 69-71.

Ughade, S. R. and Mahadkar, U. V. 2015. Effect of different planting density, irrigation and fertigation levels on growth and yield of Brinjal (*solanum melongena l.) The Bioscan.* **10(3):** 1205-1211.