Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol8 [6] May 2019 : 14-20

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD
Global Impact Factor 0.876
Universal Impact Factor 0.9804
NAAS Rating 4.95

ORIGINAL ARTICLE **OPEN ACCESS**

Studies on growth and yield of turmeric under different irrigation and nutrient management strategies at West Bengal, India

Sandeep Kumar Tripathi[1,2*], Babloo Sharma [3], R. Ray[2], Monika Devi [4] and P.Mishra[5]
[1] Soil and Land Use Survey of India, Rajendra Nagar, Hyderabad, Telangana, India
[2] Department of Soil and Water Conservation, Faculty of Agriculture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal-741252, India
[3] Krishi Vigyan Kendra (Swami Keshwanand Rajasthan Agricultural University), Pokhran, Jaisalmer, Rajasthan, India
[4] Department of Mathematics & Statistics CCS, HAU, Hisar, Haryana,India
[5].College of Agricutlure,Powarkheda,JNKVV, M.P.(India)
***Corresponding Author:** sktripathibhu@gmail.com

ABSTRACT
Turmeric is one of the most important valuable spices in India. The field experiments were conducted at the Central Research Farm, Gayeshpur (Bidhan Chandra Krishi Viswavidyalay), West Bengal, during the summer seasons of 2011 and 2012 to assess the different irrigation and nutrition schedules on the growth parameters and yield of turmeric. The trial was laid out in a split-plot design with four irrigation levels in main-plots and three nutrient levels in sub-plots with three replications. The results of the study showed that significantly maximum growth viz., plant height, dry matter accumulation, leaf area and leaf area index and yield (Fresh and crude rhizomes yield), of turmeric were observed due to the main effects of irrigation schedule at 0.9 irrigation water (IW):cumulative pan evaporation (CPE), nutrient schedule at 50 % recommended dose of fertilizer (RDF) + 25 % farm yard manure (FYM)+ 25 % vermicompost (VC)in both the years whereas the interactional effect also significant on growth and yield of turmeric.
Keywords: *Nutrients regimes, Fertilizer, Turmeric, Rhizome.*

Received 11.01.2019 Revised 10.02.2019 Accepted 21.02.2019

INTRODUCTION

The world today is discovering the magic of turmeric. Turmeric is one of the most important spice and medicinal crop grown extensively throughout the tropical and sub-tropical parts of the country. It is third important spice crop grown in India since ancient times and India enjoys monopoly in the production of turmeric [1]. Turmeric (*Curcuma longa*L.) is an herbaceous perennial plant belonging to the family, Zingiberaceae. It is an ancient, most valuable, sacred spice of India and it contains appreciable quantities of proteins (6.3%), lipids (5.1%), carbohydrates (69.4%), mineral (3.5%) and other important element on dry weight basis [2]. In India, turmeric is grown in an area of 181, 000 hectare with a production of 890,000 tonnes contributing to nearly 78 per cent of the world production during 2009-2010 [3]. It is widely cultivate in the different states of India. West Bengal is 4th major state turmeric cultivation having 11,844 ha with an annual estimated production of 25,049 tonnes and productivity is 2.11 tonnes per ha.

The utilization efficiency of nutrients is closely related with the dynamics of the nutrients in the soil-water-plant system [4]. The various management options and the interrelationships of soil-water-plant continuum eventually affect the crop yields vis-à-vis the nutrient use efficiency. Water is the most important and critical input used in agriculture. The importance of irrigation scheduling is based on the ET value which enables the farmer to apply the exact amount of water to achieve the goal. A critical element is accurate measurement of the volume of water applied or the depth of water application. Accurate water application prevents over- or under irrigation. The increase in production is possible mainly through efficient utilization of available resources. Turmeric being an exhaustive crop requires heavy manuring [5]. Specially, N and K are two important fertilizers responsible for boosting growth and yield of turmeric [6]. The increasing rates of N significantly increased the yield and other yield contributing characters of turmeric stated by Pandey [7]. Application of the organic and inorganic fertilizers is indispensable as their conjunctive use stimulates the mineralization of the nitrogen and sulphur and decreases the fixation of phosphorus and potassium in the acidic soils [8].

MATERIAL AND METHODS

The field experiment was conducted for two consecutive years (April, 2011 to November, 2012) at Central Research Farm, Gayeshpur, Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal to study on the effect of various levels of water and nutrient on yield of turmeric under New Alluvial soils of West Bengal. The Climatic condition is humid tropic. The summer is hot and the winter is moderate. Pre-monsoon rain is common in the month of April and May. Monsoon ceases during October and winter season sets in November. The average annual rainfall of this region is about 1500 mm. The soil of the experimental field is Indo-Gangetic alluvial with sandy loam in texture, good water holding capacity and moderate soil fertility status. The soils of the present site belong to the order of Inceptisol and Great Group is Aeric Haplaquept [9].

The experiment was laid out in a split-plot design with four irrigation regimes (I_1 = 0.6 IW/CPE, I_2= 0.9IW/CPE, I_3 = 1.2 IW/CPE and I_4 = rainfed) as a main-plots and three nutrient sources (N_1 = 100 %inorganic, N_2 = 75 % inorganic + 25 % FYM and N_3= 50 % inorganic + 25 % FYM + 25 %vermicompost) as sub-plots with three time repetitions. The cultivar of turmeric (Suguna) was planted on 2nd week of April at a spacing of 600 cm^2 and was harvested on last week of November in each year. The recommended dose of fertilizers for the crop was 150:75:150 NPK kg ha^{-1}. Irrigation scheduling was based on IW/CPE ratio approach with 50 mm depth of water applied in each irrigation. The growth parameters were collected at different growth stages whereas yield was obtained after harvesting of turmeric. The leaf area was computed by multiplying leaf length, leaf width and factor 0.72 [10]. The leaf area index was calculated by dividing leaf area of plant by the ground area covered [11].

The data relating to growth and yield of crop were statistically analyzed following analysis of variance method [12]. Statistical analysis and interpretation were done by calculation value of S.Em (±) and CD at 5% level of significance.

RESULT AND DISCUSSION

Plant height

The plant height of turmeric was significantly influenced by the different irrigation levels and nutritional sources at all the growth stages in both the years as indicated by data presented in table 1. At 60 DAS, maximum plant height (27.75 cm and 32.87 cm during the first and second year, respectively) was obtained under irrigation schedules of 0.9 IW: CPE (I_2) followed by irrigation schedules of 1.2 IW: CPE (I_3). The minimum plant height (20.33 cm during 2011 and 25.09 cm during 2012) was recorded with conventional rainfed situation (I_4). The similar trend of plant height was found at 150 DAS. At 60 DAS, the application of 50% RDF integrating with 25% FYM + 25% VC (N_3) was registered the maximum plant height (27.47 cm and 32.21 cm during first and second year, respectively) followed by 75% RDF and 25% FYM (N_2). The minimum plant height (22.24 cm and 26.85 cm during first and second year) was noticed with 100% RDF (N_1). As stated above, the similar effect of nutritional sources on plant height was observed at 150 DAS. Combined application of organic and inorganic fertilizer may have positive effect on plant height due to incorporation of organic manures which improves soil physical properties and use of inorganic fertilizer increases mineralization and makes the soil productive [13]. The interactions between the irrigation and nutrition levels were studied. Significant difference was observed in case of plant height in both the years at 150 DAS during 2011 and 2012 while at 60 DAS, it was shown non-significantly interaction during 2011 and significant during 2012.

Dry matter accumulation

Irrigation levels significantly influenced dry matter production plant^1 at all the stages of crop growth in both the years. At 150 DAS, irrigation schedules of 0.9 IW/CPE (I_2) were recorded significantly higher dry matter accumulation than rest of the other treatments. However, minimum dry matter accumulation was observed under conventional rainfed situation (I_4). The effect of nutrient sources was significant on total dry matter accumulation at all the growth stages. At 150 DAS, maximum dry matter accumulation was observed with N_3 (50% RDF + 25% FYM + 25% VC) while, the minimum dry matter accumulation was noticed with N_1 (100% RDF). The increased availability of plant nutrients with FYM application over a period of time due to slow release of nutrients might have resulted in better crop growth in term of dry mater accumulation [14]. Consequently, the interaction levels of irrigation and nutrient indicated significant difference in case of dry matter accumulation, t ha^{-1} (Table 1).At 60 and 150 DAS, I_2N_3

treatment produced maximum dry matter accumulation during both years while, the minimum dry matter accumulation was noticed with I_4N_1 treatment combinations.

Leaf area

At 60 DAS, maximum leaf area (229.4 cm^2 and 293.2 cm^2 during the year 2011 and 2012, respectively) was noticed with irrigation schedules of 0.9 IW: CPE (I_2) which differed significantly from other irrigation levels. Minimum leaf area (154.9 cm^2 and 184.1 cm^2 during the year 2011 and 2012, respectively) was observed with conventional rainfed situation (I_4). Leaf area of turmeric at 150 DAS was shown similar trend, it was recorded 962.1 and 1181.1 cm^2 under I_4 which was 18.44 and 19.92% lower than I_2, during 2011 and 2012, respectively (Table 2). Among different nutritional sources tried in this investigation, at 60 DAS, N_3 treatment (50% RDF + 25% FYM + 25% VC) was produced maximum leaf area (225.9 cm^2 and 274.5 cm^2 during the year 2011 and 2012, respectively). However, minimum leaf area (163.3 cm^2 and 204.0 cm^2 during the year 2011 and 2012, respectively) was recorded with N_1 treatment (100% RDF). The leaf area of turmeric plant was increased at an increasing rate up to 150 DAS. The interaction due to I_2N_3 at 60 DAS produced maximum leaf area (269.0 cm^2 and 340.3 cm^2 during the year 2011 and 2012, respectively,) followed by other treatment combinations. Significantly lower leaf area inboth the years was noticed under I_4N_1 treatment (129.4 cm^2 and 156.2 cm^2 during the year 2011 and 2012, respectively). The performance of treatment combinations on leaf are of turmeric showed significant response.

Leaf area index

Significantly higher leaf area index at 60 and 150 DAS (0.38, 0.49, 1.97 and 2.46 during the year 2011 and 2012, respectively) were observed when irrigation schedules of 0.9 IW: CPE (I_2) was applied to turmeric crop. Minimum leaf area index was observed with conventional rainfed situation (I_4) at all growth stages during both years (Table 2). The effect of different nutritional sources has much influence on leaf area index. At 60 DAS, the application of nutrition through N_3 treatment (50% RDF + 25% FYM + 25% VC) was produced maximum leaf area index (0.38 and 0.46 during the year 2011 and 2012, respectively) and minimum leaf area index (0.27 and 0.34 during both the year) was recorded with N_1 treatment (100% RDF). The similar pattern of leaf area index at 150 DAS was obtained during both the years. Singh *et al.* reported that the leaf area index (LAI) reached a peak with recommended rates of NPK fertilizers were applied [15]. Leaf area index and dry matter production were maximum under irrigation with a proper drainage system. Accordingly, interaction of irrigation and nutritional levels are concerned, significant difference was observed in case of leaf area index. The interaction of the irrigation levels and nutritional sources, I_2N_3 treatment produced maximum leaf area index (0.51 and 2.36 at 60, and 150 DAS, respectively) followed by other treatment combinations. Significantly lower leaf area index was noticed with I_4N_1 treatment combination (0.24 and 1.61 at 60 and 150 DAS, respectively).

Fresh rhizome yield

The data in figure 1, indicated that the fresh rhizome yield of turmeric (t ha^{-1}) was significantly affected by different irrigation and nutrient sources. The maximum fresh rhizome yield of turmeric (22.99 and 24.82 t ha^{-1} during first and second year, respectively) was recorded by I_2 irrigation (0.9 IW/CPE), followed by I_3 (22.81 and 24.08 t ha^{-1} during first and second year, respectively).The lowest fresh rhizome yield of turmeric (14.78 and 15.70 t ha^{-1} during first and second year, respectively) was recorded in the treatment I_4 (rainfed). The significant increase in fresh rhizome yield is attributed to adequate moisture in the rhizosphere resulting in better uptake of nutrients with increased plant growth, yield and yield components [16].

Different nutrient sources affected the fresh rhizome yield of turmeric significantly. Maximum fresh rhizome yield (21.10 and 22.62 t ha^{-1} during first and second year, respectively) was observed with N_3 (50 % RDF integrating with 25 % FYM + 25 % VC) whereas minimum fresh rhizome yield (18.82 and 20.24 t ha^{-1} during first and second year, respectively) was recorded with N_1 (100 % RDF). Yamgar and Pawar recorded the highest rhizome yield with 120:60:60 kg N, P, K ha^{-1} [17]. Kumar *et al*. observed that turmeric yield was positively correlated with soil N, P and K contents [18]. Different interaction levels among irrigation and nutrient sources showed significant effect with respect to fresh rhizome yield of turmeric. The maximum fresh rhizome yield was recorded with I_2N_3 followed by other treatment combinations. Significantly lower fresh rhizome yield was noticed under I_4N_1 treatment combinations. The low rhizome yield in rainfed crop may be due to water stress during rhizome initiation and rhizome bulking stage.

Cured rhizome yield

Maximum cured rhizome yield was recorded when crop irrigated with I_2 (0.9 IW: CPE), followed by I_3 (1.2 IW: CPE) irrigation levels (Figure 2). The minimum cured rhizome yield (2.86 and 3.08 t ha^{-1} during first and second year, respectively) was observed with I_4 (rainfed). Among different nutrient sources, N_3 (50% RDF + 25%FYM + 25% VC) was produced maximum cured rhizome yield (4.21 and 4.46 t ha^{-1} during first and second year, respectively) as compared to minimum cured rhizome yield (3.61 and 3.91 t ha^{-1} during first and second year, respectively) was recorded with N_1 (100 % RDF). So far, as interaction levels are concerned, significant difference was observed in case of cured rhizome yield. I_2N_3 treatment combinations produced maximum cured rhizome yield and minimum cured rhizome yield was noticed with I_4N_1 treatment combinations. The lowest cured rhizome yield was observed due to low water and nutrient availability of turmeric under rainfed condition and conformity of statement was written by Tripathi *et al*. [19].

CONCLUSION

Genotypes differed significantly in growth parameters like plant height, number of branches per plant at all crop growth stages except 90 DAS and maturity in case of number of branches per plant. At maturity plant height and branches /plant were maximum in PhuleG 405 followed by RVG 203, NBeG 452, JG 16 and JG 36 while minimum in JG 315. Genotypes did differ in number and dry weight of nodules per plant at all stages of observations. except 60 DAS. The crop growth rate varied significantly in different genotypes. PhuleG 405 recorded significantly higher crop growth rate over rest of the genotypes except RVG 203 and JG 16, Relative growth rate differ significantly among the genotypes. The genotypes PhuleG 405 had highest number of pods per plant and seed yield per plant as well as seed index was found highest in PhuleG 405 followed by RVG 203, NBeG 452, JG 16 and JG 36. Minimum value of all the yield attributing characters was obtained in JG 315. The seeds /pod influence significantly due to genotypes. Seed and straw yields differed according to genotypes and highest values were obtained from PhuleG 405 (1547kg/ha seed and 1745kg/ha straw yield). Harvest index for different genotypes did vary significantly.

Table. 1 Effect of irrigation and nutrients regimes on plant height and dry matter accumulation in turmeric at various growth stages

Treatment	Plant height (cm)				Dry matter accumulation (t ha^{-1})			
	60 DAS		150 DAS		60 DAS		150 DAS	
	2011	2012	2011	2012	2011	2012	2011	2012
Irrigation Levels								
I_1	24.84	29.53	118.40	124.21	2.61	3.18	6.35	6.02
I_2	27.75	32.87	124.96	132.58	3.18	4.04	7.31	6.81
I_3	26.09	30.30	122.19	128.79	2.87	3.46	6.83	6.43
I_4	20.33	25.09	115.52	119.79	2.08	2.44	5.77	5.42
SEm (±)	0.89	1.15	0.84	0.58	0.04	0.04	0.12	0.07
CD at 5%	3.08	3.99	2.92	2.02	0.14	0.14	0.41	0.20
Nutrient Levels								
N_1	22.24	26.85	117.83	124.06	2.22	2.51	5.81	5.57
N_2	24.55	29.28	119.92	126.69	2.67	3.39	6.68	6.22
N_3	27.47	32.21	123.04	128.28	3.17	3.94	7.20	6.71
SEm (±)	0.53	0.31	0.41	0.60	0.06	0.04	0.04	0.03
CD at 5%	1.59	0.92	1.21	1.79	0.18	0.11	0.13	0.07
Interaction								
I_1N_1	22.33	26.38	117.12	123.08	2.02	2.19	5.20	5.41
I_1N_2	24.66	29.07	118.04	123.55	2.57	3.30	5.61	6.51
I_1N_3	27.52	33.14	120.05	126.00	3.23	4.05	6.22	7.15
I_2N_1	24.67	29.05	121.11	129.22	2.58	3.07	5.79	6.52
I_2N_2	27.33	32.45	123.76	133.56	3.21	4.24	6.39	7.41
I_2N_3	31.25	37.11	130.02	134.96	3.74	4.80	6.73	8.01
I_3N_1	23.34	27.73	119.56	128.80	2.35	2.71	5.51	6.02
I_3N_2	26.47	30.43	122.00	127.71	2.87	3.56	6.02	6.91
I_3N_3	28.46	32.75	125.00	129.87	3.38	4.12	6.55	7.55
I_4N_1	18.60	24.25	113.56	115.13	1.91	2.07	4.81	5.29
I_4N_2	19.74	25.17	115.89	121.96	2.01	2.44	5.06	5.89
I_4N_3	22.63	25.84	117.11	122.29	2.33	2.81	5.36	6.11
I×N [SEm (±)]	1.06	0.61	0.81	1.19	0.12	0.07	0.07	0.09
N×I [SEm (±)]	1.24	1.26	1.07	1.13	0.11	0.07	0.08	0.14
I×N (CD at 5%)	NS	1.84	2.43	3.57	0.36	0.22	0.21	0.26
N×I (CD at 5%)	NS	4.26	3.52	3.54	0.33	0.23	0.26	0.46

Table 2 Effect of irrigation and nutrients regimes on Leaf area and Leaf area index in turmeric at various growth stages

Treatment	Leaf area (cm^2)				Leaf area index			
	60 DAS		150 DAS		60 DAS		150 DAS	
	2011	2012	2011	2012	2011	2012	2011	2012
Irrigation Levels								
I_1	178.8	210.0	1103.3	1385.5	0.30	0.35	1.84	2.31
I_2	229.4	293.2	1179.6	1474.9	0.38	0.49	1.97	2.46
I_3	214.0	266.2	1140.2	1426.2	0.36	0.44	1.90	2.38
I_4	154.9	184.1	962.1	1181.1	0.26	0.31	1.60	1.97
SEm (±)	5.17	7.13	17.35	23.86	0.009	0.012	0.029	0.040
CD at 5%	17.88	24.69	60.04	82.57	0.030	0.041	0.100	0.138
Nutrient Levels								
N_1	163.3	204.0	1015.1	1254.4	0.27	0.34	1.69	2.09
N_2	193.6	236.7	1104.8	1384.6	0.32	0.39	1.84	2.31
N_3	225.9	274.5	1169.0	1461.9	0.38	0.46	1.95	2.44
SEm (±)	1.60	2.47	7.34	10.56	0.003	0.004	0.015	0.018
CD at 5%	4.78	7.41	24.21	31.65	0.008	0.012	0.037	0.053
Interaction								
I_1N_1	152.4	183.1	1043.9	1302.1	0.25	0.31	1.74	2.17
I_1N_2	181.7	209.2	1119.6	1411.4	0.30	0.35	1.87	2.35
I_1N_3	202.4	237.7	1146.5	1443.2	0.34	0.40	1.91	2.41
I_2N_1	190.8	248.6	1086.7	1350.4	0.32	0.41	1.81	2.25
I_2N_2	228.2	290.6	1194.9	1504.5	0.38	0.48	1.99	2.51
I_2N_3	269.0	340.3	1257.1	1569.9	0.45	0.57	2.10	2.62
I_3N_1	180.6	228.0	1053.7	1309.9	0.30	0.38	1.76	2.18
I_3N_2	214.1	267.0	1136.7	1431.8	0.36	0.44	1.89	2.39
I_3N_3	247.2	303.5	1230.2	1536.9	0.41	0.51	2.05	2.56
I_4N_1	129.4	156.2	876.1	1055.0	0.22	0.26	1.46	1.76
I_4N_2	150.3	179.9	968.1	1190.8	0.25	0.30	1.61	1.98
I_4N_3	184.8	216.3	1042.1	1297.7	0.31	0.36	1.74	2.16
I×N [SEm (±)]	3.19	4.94	21.12	14.68	0.006	0.008	0.035	0.024
N×I [SEm (±)]	5.79	8.20	24.46	26.70	0.010	0.014	0.041	0.045
I×N (CD at 5%)	9.57	14.82	62.31	44.00	0.016	0.025	0.106	0.119
N×I (CD at 5%)	19.48	27.45	80.02	89.91	0.032	0.046	0.132	0.150

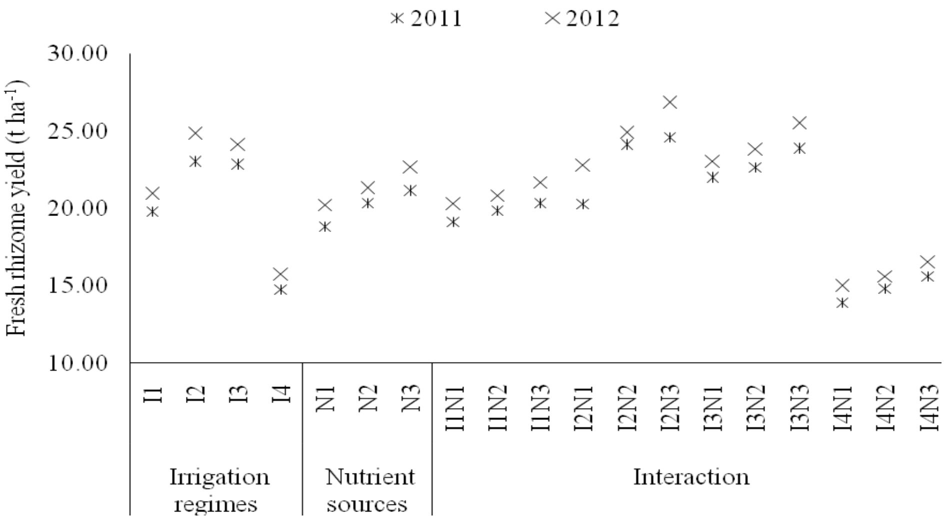

Figure 1. Influence of irrigation regimes and nutrient sources on fresh rhizome yield of turmeric

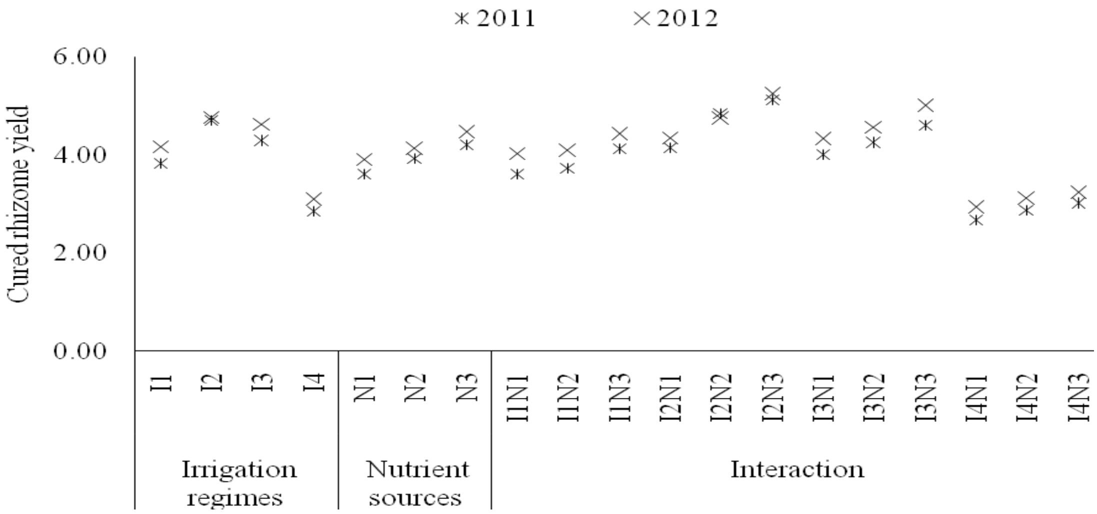

Figure 2. Impact of irrigation regimes and nutrient sources on cured rhizome yield of turmeric

REFERENCES

1. Pandey, D.K., Mishra, D.P. and Mustafa, Md. (2011) Response of various level of nitrogen and plant spacing on yield and yield attributing characters of turmeric (*Curcuma longa* L.) at farmers field of Azamgarh, U.P. *Progressive Horticulture,***43**(2): 320-322.
2. Shakur, M.A. (2000) Turmeric cultivation method (Bengali), Spices Research Centre, Bangladesh Agricultural Research Institute, Bogra, Bangladesh.
3. Krishnamoorthy, C., Soorianathasundaram, K., Rajamani, K. and Selvaraj, P.K. (2012) Impact of Fertigation on leaf nutrient status and yield attributes in turmeric (*Curcuma longa L.*) cv.BSR 2. *Madras Agricultural Journal*, **99**(10-12): 739- 742.
4. Acharya, C.L. (2008) Soil water plant relationship and input use efficiency. *Journal of Indian Society of Soil Science*, **56**(4): 404-413.
5. Subramanian, K.S., Sivasamy, N. and Thangaraj, T. (2001) Integrated nutrient management for turmeric. *Spice India*, **14**: 25-26.
6. Banafar, R.B.S. and Tiwari, R.J. (1995) Response of turmeric to potassium application in medium black soils of Madhya Pradesh. *Crops Research* (Hisar), **10**(1): 93-95.
7. Pandey, A. K. (1992) Response of turmeric to various levels of nitrogen under terrace condition of mid altitude, Mizoram. *Indian Cocoa, Account and Spices Journal*, **16**(1): 14-16.
8. Singh, M.S., Singh, V.P. and Reddy, S. (2001) Effect of integrated fertilizer nitrogen and farm yard manure or green manure on transformation of N, K and S and productivity of Rice-Wheat system on vertisol. *Journal of Indian Society of Soil Science,***49**: 430-32.
9. NBSSLUP, (2001). Soil Series of West Bengal, National Bureau of Soil Survay and Land Use Planning (NBSSLUP) Nagpur, India, pp. 260.
10. Rao, D. V. R. and Swamy, G. S. (1984) Studies on the effect of N, P and K on growth, yield and quality of turmeric. *South Indian Horticulture,* **32**(5): 288-291.
11. Sestak,A., Catsky, J. and Jarvis, P. G. (1971) Plant Photosynthetic Production, Manual of Methods (Ed. Junk, W.). N. V. Publications, *The Hughus*, pp. 343-381.
12. Gomez, K. A. and Gomez, A. A. (1984) Statistical Procedures for Agricultural Research, 2nd edn. Singapore: John Wiley & Sons.
13. Huang, B., Sun, W.Z., Hao, Y.Z., Hu, J., Yang, R., Zou, Z., Ding, F. and Su, J. (2007) Temporal and spatial variability of soil organic matter and total nitrogen in an agricultural ecosystem as affected by farming practices. *Geoderma*. **139**: 336-345.
14. Manhas, S.S. and Gill, B.S. (2010) Effect of planting materials, mulch levels and farmyard manure on growth, yield and quality (Curcuma longa) *Indian Journal of Agricultural Science,***80** (6): 501-506.
15. Singh, J.P., Prasad, U.K., Singh, H. (2000) Effect of irrigation and drainage requirement on water-use efficiency and yield of pure [crops] and maize (Zea mays)-based intercrops. *Indian Journal of Agricultural Sciences*, **70**(2): 65-68.
16. Tripathi, S.K., Sharma, B., Meena, S.K., Ray, R. and Patra, S.K. (2015). Influence of Irrigation Schedules and Nutrient Sources on Yield, Quality, Water Use and Water Productivity of Turmeric under Alluvial Soils of West Bengal. *Journal of Pure & Applied Microbiology*, **9**(4): 3109-3114.
17. Yamgar, V.T., Pawar, H.K. (1991) Studies on the fertilizer sources on yield of turmeric. *Journal of Plantation Crops,***19**(1): 61-62.
18. Kumar, T.V., Reddy, M.S. and Krishna, V.G. (1997). Nutrient status of turmic growing soils in Northen Telangana Zone of Andhra Pradesh. *Journal of Plantation Crops.***25**(1): 93-97.

19. Tripathi, S.K., Sharma, B., Ray, R., Raha, P. and Denis, A.F. (2018) Performance of Turmeric and Soil Moisture Depletion Pattern Under Different Water Regimes and Nutrient Sources at New Alluvial Zone of Indo-Gangetic Plains, India, *Communications in Soil Science and Plant Analysis*, **49**(9): 995-1008. DOI:10.1080 /00103624. 2018.1448405.

CITATION OF THIS ARTICLE

Sandeep Kumar Tripathi, Babloo Sharma , R. Ray, Monika Devi and P.Mishra, Studies on growth and yield of turmeric under different irrigation and nutrient management strategies at West Bengal, India. Bull. Env. Pharmacol. Life Sci., Vol 8 [6] May 2019: 14-20