Madras Agric. J., 99 (10-12): 739-742, December 2012
https://doi.org/10.29321/MAJ.10.100184

Impact of Fertigation on Leaf Nutrient Status and Yield Attributes in Turmeric (*Curcuma longa* L.) cv. BSR 2

C. Krishnamoorthy*, K. Soorianathasundaram, K. Rajamani and P.K. Selvaraj
Department of Spices and Plantation Crops
Horticultural College and Research Institute
Tamil Nadu Agricultural University, Coimbatore - 641 003

A field experiment to study the soil, plant nutrient status and yield of turmeric (*Curcuma longa* L.) cv. BSR 2 as influenced by fertigation of N and K fertilizers was carried out during June 2007 to February 2008. The experiment consisted of seven treatments replicated four times in a randomized block design. The soil nutrient parameters *viz*., available soil nitrogen, phosphorous, potassium content and plant nutrient parameters *viz*., leaf nitrogen, phosphorous and potassium were recorded. The yield parameters *viz*., number of mother, primary and secondary rhizomes, length and girth of mother, primary and secondary rhizomes, weight of mother, primary and secondary rhizomes, fresh, cured rhizome yield plant^{-1} and estimated cured rhizome yield hectare^{-1} were also recorded. The study revealed that the soil and plant nutrient contents in general increased upto 150 days and then declined. Among the several treatments, N + K @ 100 % level (150 : 108 NK kg ha^{-1}) by fertigation using water soluble fertilizers *viz*., Urea and Multi 'K' registered the highest values for the soil, plant nutrient content and yield parameters.

Key words: Fertigation, soil, leaf nutrients, yield, water soluble fertilizers, straight fertilizers.

Turmeric (*Curcuma longa* L.) is a herbaceous perennial belonging to the family Zingiberaceae and is one of the important commercial spice crops of the tropics. Besides India, it is distributed in Cambodia, China, Indonesia, Madagascar, Malaysia, Philippines and Vietnam. Apart from its religious significance in India, this crop is being used as a culinary spice, in cosmetic preparations, as food preservative, colouring agent and also for its pharmaceutical properties. The rhizomes of turmeric and its powder have been used extensively in the Indian systems of medicine (Ayurveda, Unani and Siddha). In the recent past, its colouring principle "Curcumin" (chemically diferulolyl methane), has been established to have wide spectrum of biological and pharmacological activities including antioxidant, anti-inflammatory, hypoglycemic, antimicrobial, antiviral and anticancerous properties (Julie Jurenka, 2009).

In India, turmeric is grown in an area of 1,81,000 ha with an production of 8,90,000 tonnes contributing to nearly 78 per cent of the world production during 2009-2010. It is widely cultivated in the states of Andhra Pradesh, Tamil Nadu, Orissa, Karnataka, Kerala, Maharashtra and West Bengal. In Tamil Nadu, it is cultivated mainly in Erode, Salem, Coimbatore and Namakkal districts in an area of 51,446 ha with an annual estimated production of 2,77,980 tonnes.

*Corresponding author email: plantdoctorkrishna@gmail.com

Owing to its long duration and high productivity, turmeric requires heavy input of fertilizers (Syed Sadarunnisa *et al*., 2010). In Tamil Nadu, a nutrient dosage of 150: 60: 108 kg NPK ha^{-1} has been generally recommended (TNAU, 2004) . In almost all the turmeric growing regions, the nutritional requirements are met through application of fertilizers in the soil. Split application of nutrients, especially nitrogen and potassium, has been recommended to improve the yield and quality (Jagadeeswaran *et al*., 2004).

Of late, fertigation *i.e*. application of fertilizer through drip irrigation has been found to dramatically improve the yield and quality of many horticultural crops (Ashok and Alva, 2008). Enhancement of yield and quality of various crops has been reported by using water soluble fertilizers in fertigation (Hebbar *et al*., 2004). Hence, the present study was taken up in turmeric cv. BSR 2 with the objective of studying the impact of fertigation in the soil, plant nutrient status and yield in turmeric cv. BSR 2.

Materials and Methods

A field experiment to study the influence of fertigation of N and K fertilizers on the soil nutrient status of turmeric (*Curcuma longa* L.) cv. BSR 2 was carried out during June 2007 to February 2008, at the Agricultural Research Station, Bhavanisagar, Erode district. Each treatmental plot measured 7.8 m length and 3 m width. A spacing of 45 cm between rows within a paired row, 55 cm between two adjacent paired rows and 15 cm with in each row was maintained. Thus each plant occupied an area of 0.075 m^2. In treatments receiving fertigation, drip laterals were laid along the length of each paired row at the centre with the spacing kept at 1 m between two adjacent laterals. In control plot, instead of drip laterals, provision for surface irrigation was provided for the paired rows. A venturi assembly was used for mixing fertilizer with irrigation water.

The experiment was laid out with seven treatments with four replications adopting randomized block design (RBD). The details of the treatments are ; T_1 - Recommended dose of NPK (150: 60: 108 kg ha^{-1}) through straight fertilizers *i.e*. Urea and MOP by soil application + surface irrigation (control), T_2 - N+K@ 100 % level by fertigation using straight fertilizers (Urea and MOP), T_3 - N+K@ 75 % level by fertigation using straight fertilizers (Urea and MOP), T_4 - N+K@ 50 % level by fertigation using straight fertilizers (Urea and MOP), T_5 - N+K@ 100 % level by fertigation using water soluble fertilizers (Urea and Multi 'K'), T_6 - N+K@ 75 % level by fertigation using water soluble fertilizers (Urea and Multi 'K'), T_7 - N+K@ 50 % level by fertigation using water soluble fertilizers (Urea and Multi 'K').

The fertilizers were applied through drip irrigation at weekly intervals by following the schedule by which 50 % of total N and 30 % of total K were applied from 4^{th} to 11^{th} weeks, 40 % of total N and 50 % of total K are applied from 12^{th} to 23^{rd} weeks. The remaining quantity of 10 % N and 20 % K were applied from 24^{th} to 28^{th} weeks. In all the fertigation treatments, the full dose of phosphorus (60 kg ha^{-1}) was applied as basal using single super phosphate (16 % available P) as the source. The standard recommended cultural practices (TNAU, 2004) were followed for managing the crop except for the fertigation treatments envisaged in the study.

Soil samples were drawn at 90^{th}, 150^{th}, 210^{th}, 257^{th} day (harvest) and the leaf samples (third youngest leaf was used as standard leaf) were collected at 90^{th}, 150^{th}, 210^{th} and 240^{th} days after sowing (DAS) and the samples are analyzed as per standard procedures (Subbiah and Asija, 1956; Humphries, 1956).

Results and Discussion

The applied nutrients at any stage of application should properly reflect in terms of available nutrients in the soil system so that the plants could absorb these nutrients without any hindrance. The initial N content in the soil was 180.43 kg ha^{-1} (Table 1). At 90 DAS and 150 DAS, the nitrogen content was more in the control (T_1) and at 150 DAS and harvest time, the N content was more in the treatment T_5 (N+K @ 100 % level by fertigation using water soluble fertilizers). Reduced levels of soil nitrogen in fertigation treatments upto 150 DAS indicate the possibility of better uptake and utilization in the early stages of vegetative growth. Early stage requirement of nitrogen was emphasized earlier by Jagadeeswaran *et al*. (2004).

Table 1. Influence of straight and water soluble fertilizers on soil nitrogen content (kg ha^{-1})

Treatment	Initial soil N content (kg ha^{-1})	Soil N content at 90 DAS (kg ha^{-1})	Soil N content at 150 DAS (kg ha^{-1})	Soil N content at 210 DAS (kg ha^{-1})	Soil N content at harvest (kg ha^{-1})
T_1	180.4	202.7	221.2	187.5	170.2
T_2		193.6	209.9	196.0	179.0
T_3		184.3	198.2	187.8	169.5
T_4		177.7	188.6	179.2	163.7
T_5		192.9	211.0	198.2	178.2
T_6		183.3	199.2	189.0	170.7
T_7		176.1	189.7	178.4	161.4
SEd	-	5.8	6.3	5.8	5.3
CD (0.05)	-	12.2	13.2	12.2	11.1

As regard to soil phosphorus content, the differences between different treatments were not significant. It should be noted that the phosphorous was applied as basal dose in all the treatments. Initially at 90 DAS, the phosphorus contents were increased and then declined (Table 2). Phosphorus requirement for turmeric was considered generally low (60 kg ha^{-1}) and is required in early stages (Yamgar *et al* ., 2001). However, similar to soil N levels the soil potassium content were also lesser in fertigation treatments compared to conventional way of fertilizer application. The treatment T_5 recorded a potassium content of 248.0, 274.5, 265.3 and 230.1 kg ha^{-1} at 90, 150, 210 DAS and at harvesting stage (Table 3). Scheduling of N and K nutrients

Table 2. Influence of straight and water soluble fertilizers on soil phosphorus content (kg ha^{-1})

Treatment	Initial soil P content (kg ha^{-1})	Soil P content at 90 DAS (kg ha^{-1})	Soil P content at 150 DAS (kg ha^{-1})	Soil P content at 210 DAS (kg ha^{-1})	Soil P content at harvest (kg ha^{-1})
T_1	36.2	54.5	43.7	39.2	34.0
T_2		53.9	42.0	37.5	33.7
T_3		54.9	43.4	38.7	34.7
T_4		55.2	46.9	40.4	35.0
T_5		52.5	43.2	36.1	31.9
T_6		54.8	44.0	38.0	33.1
T_7		55.6	45.8	39.6	34.3
SEd	-	1. 7	1.4	1.2	1.1
CD (0.05)	-	NS	NS	NS	NS

Table 3. Influence of straight and water soluble fertilizers on soil potassium content (kg ha^{-1})

Treatment	Initial soil K content (kg ha^{-1})	Soil K content at 90 DAS (kg ha^{-1})	Soil K content at 150 DAS (kg ha^{-1})	Soil K content at 210 DAS (kg ha^{-1})	Soil K content at harvest (kg ha^{-1})
T_1	232.1	258.7	280.5	256.5	227.3
T_2		246.6	270.3	261.7	228.5
T_3		239.7	262.6	252.2	220.3
T_4		232.5	254.1	247.8	214.0
T_5		248.1	274.5	265.3	230.1
T_6		240.8	263.2	253.2	221.9
T_7		233.1	255.2	246.5	215.6
SEd	-	7.5	8.2	7.9	6.9
CD (0.05)	-	15.8	17.3	NS	NS

corresponding to the growth stages could have enabled better nutrient uptake and utilization in the fertigation treatments.

Fertigation using water soluble fertilizers registered higher concentration of leaf NPK than straight fertilizers. It can be deduced from the data

Table 4. Influence of straight and water soluble fertilizers on leaf nitrogen and phosphorus content (per cent)

Treatment	Leaf N content (Per cent)				Leaf P content (Per cent)			
	90 DAS	150 DAS	210 DAS	240 DAS	90 DAS	150 DAS	210 DAS	240 DAS
T_1	1.09	1.14	1.08	1.01	0.20	0.23	0.19	0.16
T_2	1.30	1.38	1.34	1.24	0.25	0.31	0.27	0.21
T_3	1.24	1.30	1.26	1.20	0.24	0.28	0.24	0.20
T_4	1.14	1.19	1.15	1.09	0.22	0.25	0.21	0.18
T_5	1.40	1.50	1.44	1.32	0.29	0.36	0.31	0.26
T_6	1.33	1.44	1.39	1.28	0.27	0.34	0.29	0.24
T_7	1.20	1.26	1.20	1.14	0.23	0.27	0.22	0.19
SEd	0.03	0.04	0.03	0.03	0.01	0.01	0.01	0.01
CD (0.05)	0.08	0.09	0.08	0.08	0.02	0.02	0.02	0.01

that fertigation with straight or water soluble fertilizers especially at 75 % and 100 % levels improved leaf nutrient concentrations.

Table 5. Influence of straight and water soluble fertilizers on leaf potassium content (per cent)

Treatment	Leaf K content (Per cent)			
	90 DAS	150 DAS	210 DAS	240 DAS
T_1	3.02	3.42	3.24	3.05
T_2	3.47	3.67	3.58	3.30
T_3	3.39	3.56	3.49	3.19
T_4	3.21	3.40	3.31	3.10
T_5	3.70	3.98	3.86	3.56
T_6	3.58	3.76	3.64	3.38
T_7	3.20	3.44	3.38	3.15
SEd	0.10	0.11	0.11	0.10
CD (0.05)	0.22	0.23	0.23	0.21

The treatment T_5 registered significantly higher nitrogen contents in all the four stages while T_1 (control) recorded the least. Among the different stages, the highest leaf phosphorus content was recorded at 150 DAS and was in the range of 0.23 to 0.36 per cent (Table 4). However, similar to leaf nitrogen the leaf phosphorus content were higher in the treatment T_5.

In general, the leaf potassium increased upto 150 DAS and then it declined (Table 5). Among the different treatments, T_5 registered highest leaf potassium content of 3.70 percent (90 DAS), 3.98 percent (150 DAS), 3.86 percent (210 DAS) and 3.56 percent (240 DAS). These observations clearly demonstrate the enhanced uptake of major nutrients especially N and K when water soluble fertilizers are used.

Leaf NPK concentrations increased gradually from the initial stage to 90 DAS, attained peak levels

Table 6. Influence of straight and water soluble fertilizers on rhizome characters

Treatment	Number plant^{-1}			Length (cm)			Girth (cm)		
	Mother rhizomes	Primary rhizomes	Secondary rhizomes	Mother rhizomes	Primary rhizomes	Secondary rhizomes	Mother rhizomes	Primary rhizomes	Secondary rhizomes
T_1	2.08	6.82	10.67	3.54	9.18	1.68	3.14	1.48	1.10
T_2	3.10	10.47	15.40	4.55	10.10	2.08	3.61	1.91	1.25
T_3	2.85	10.05	14.28	4.30	9.81	1.95	3.49	1.76	1.21
T_4	2.64	9.24	13.50	4.00	9.64	1.76	3.28	1.57	1.14
T_5	3.65	12.24	17.84	4.98	10.47	2.26	3.94	2.14	1.36
T_6	3.40	11.85	16.21	4.72	10.24	2.14	3.76	2.01	1.30
T_7	2.75	9.85	13.85	4.15	9.75	1.82	3.36	1.63	1.18
SEd	0.09	0.31	0.45	0.13	0.31	0.06	0.11	0.06	0.04
CD (0.05)	0.19	0.66	0.95	0.28	0.64	0.13	0.23	0.12	0.08

at 150 DAS and declined later. This clearly implies the necessity to apply both N and K especially during the early stages for maintaining optimal levels of leaf nutrient concentrations in turmeric.

Among the treatments, T_5 registered significantly higher number of mother rhizomes (3.65), primary rhizomes (12.24) and secondary rhizomes (17.84). T_5 also recorded highest length and girth of mother rhizome (4.98 and 3.94cm), primary rhizome (10.47 and 2.14 cm) and secondary rhizome (2.26 and 1.36 cm). The highest weight of mother rhizomes (0.089 kg), primary rhizomes (0.169 kg) and secondary rhizomes (0.087 kg) was also recorded in T_5 (Table 6).

The fresh rhizome yield per plant ranged from 0.220 kg (T_1) to 0.340 kg (T_5). The estimated fresh rhizome yield was the highest in T_5 with 43.2 t ha^{-1}. Soil application of straight fertilizers (T_1) registered the lowest fresh rhizome yield of 28.7 t ha^{-1} . The highest estimated cured rhizome yield of 7.4 t ha^{-1}

was obtained in T_5 where as the lowest was in T_1 (4.9 t ha^{-1}) (Table 7).

These results clearly demonstrates that, fertigation with the higher levels of N and K especially in water soluble forms has definitely influenced the leaf nutrient status, growth and physiological attributes, which reflected in higher yield and improved rhizome traits. The leaf NPK levels as recorded in T_5 may be considered as bench marks for obtaining higher yield in turmeric. Fontes *et al.* (2000) have also pointed out that application of N and K in combination with drip irrigation maximizes the mobility of nutrients around the root zone. The results obtained in the present study are further corroborated by similar yield improvements in tomato (Deshmukh and Takte, 2007) and in onion (Muralikrishnasamy *et al.,* 2005).

Table 7. Influence of straight and water soluble fertilizers on yield

Treatment	Weight (kg $plant^{-1}$)			Fresh rhizome yield $plant^{-1}$ (kg $plant^{-1}$)	Estimated fresh rhizome yield (t ha^{-1})	Estimated cured rhizome yield (t ha^{-1})
	Mother rhizomes	Primary rhizomes	Secondary rhizomes			
T_1	0.054	0.109	0.057	0.220	28.7	4.9
T_2	0.083	0.152	0.085	0.320	38.5	6.6
T_3	0.078	0.161	0.072	0.311	37.5	6.4
T_4	0.074	0.147	0.075	0.296	36.6	6.3
T_5	0.089	0.169	0.087	0.340	43.2	7.4
T_6	0.083	0.165	0.082	0.335	41.2	7.0
T_7	0.076	0.148	0.078	0.302	37.1	6.3
SEd	0.002	0.004	0.002	0.009	1.2	2.0
CD (0.05)	0.005	0.009	0.005	0.019	2.5	4.2

Conclusion

Studies taken up in fertigation with turmeric cultivar BSR 2 indicated that a dosage of N + K @ 100 % level by drip fertigation using water soluble fertilizers along with basal application of 'P' alone can remarkably improved the leaf nutrient status and resulted in 50 % higher yield, compared to conventional method of soil application and surface irrigation. This fertigation treatment resulted in a yield of 7.4 t ha^{-1} as compared to 4.9 t ha^{-1} in control.

References

Ashok, K. and Alva. 2008. Advances in nitrogen fertigation of citrus. *J. Crop Improv.,* **22:** 121-146.

Department of Agriculture and Cooperation (Horticulture Division). 2011. Ministry of Agriculture, New Delhi, Government of India.

Deshmukh, M. R. and Takte, R. L. 2007. Effect of fertigation on growth and yield of tomato. *J. Maharashtra Agric. Univ.,* **32:** 181 - 183.

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

Hebbar, S.S., Ramachandrappa, B.K., Nanjappa, H.V. and Prabhakar, M. 2004. Studies on NPK drip fertigation in field grown tomato (*Lycopersicon esculentum* Mill.). *Europ. J. Agronomy,* **21:** 117-127.

Humphries, K.C. 1956. Mineral components and analysis; In: A Modern Method of Plant Analysis, Springer Verlag, **22:** 468-502.

Jagadeeswaran, R., Arulmozhiselvan, K., Govindaswamy, M. and Murugappan, V. 2004. Studies on nitrogen use efficiency in turmeric using ^{15}N tagged urea. *J. Nuclear Agric. Biol.,* **33**: 69-76.

Julie Jurenka. 2009. Anti-inflammatory properties of curcumin, a major constituent of *Curcuma longa:* A review of preclinical and clinical research. *Curr. Sci*., **14:** 12-19.

Muralikrishnasamy, S., Veerabadran, V., Krishnasamy, S., Kumar, V. and Sakthivel, S. 2005. Micro sprinkler irrigation and fertigation (*Allium cepa*). In *Proc* 7^{th} Int. Micro Irrigation Congress. p. 49-57.

Subbiah, B.V. and Asija, G.L.1956. A rapid procedure for estimation of available NPK in soil. *Curr. Sci*., **25:** 259-260.

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

TNAU. 2004. Crop Production Techniques of Horticultural Crops, Tamil Nadu Agricultural University, Coimbatore and Directorate of Horticulture and Plantation Crops, Chennai. p. 289.

Yamgar, V.T., Kathmale, D.K., Belhekar, P.S., Patil, R.C. and Paul, P.S. 2001. Effect of different levels of nitrogen, phosphorus and potassium and split application of N on growth and yield of turmeric (*Curcuma longa*). *Indian J. Agron.,* **46:** 372-374.

Received: April 9, 2012; Accepted: June 22, 2012