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# Fertigation of N and K on the fertilizer use efficiency in turmeric (*Curcuma longa* L.) transplants

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**ABSTRACT**

*An experiment was conducted at college orchard, Department of Spices and Plantation Crops, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore from 2014 to 2016 to study the nutrient use efficiencies of N and K under fertigation system in turmeric transplants. The experiment consisted of nine treatments replicated three times in a Randomized Block Design. The results indicated that the leaf nutrient content and nutrient use efficiencies viz., nitrogen use efficiency, phosphorus use efficiency and potassium use efficiency were significantly enhanced by the fertigation treatments than soil application of nutrients.*

***Keywords***: Fertigation, fertilizer use efficiency, turmeric transplants

Spices are high-value export oriented crops, which play an important role in agricultural economy of the country. Among the spices turmeric is one of the most important and popular spice and also a traditional item of export. It is the third most important spice crop of India, next to chillies and black pepper and it is cultivated in an area of 184.4 thousand hectares with an annual production of 830.4 thousand tonnes and productivity of 4.5 MT $ha^{-1}$ (Indiastat, 2016).Crop productivity measured in terms of responses to fertilizers can only be sustained if soil fertility levels are maintained to match with crop's need and in proper proportions. In order to sustain the production system, it is essential that the nutrient demand of a crop to produce a target yield and the amount removed from the soil be perfectly matched (Jagadeeswaran *et al*., 2005).

Among the various factors affecting productivity of turmeric, improper nutritional management practices and inadequate irrigation during critical crop growth stages can be considered as foremost contributing to low yields. Turmeric is a highly input responsive crop. It's extended crop growth period and nutrient exhaustion requires sufficient amount of nutrients and irrigation to produce higher yields with improved quality. Response of turmeric to increased levels of fertilizer has been significant (Parthasarathy *et al*., 2010). Being a nutrient exhaustive crop, turmeric is known to respond generally well to increased soil fertility levels (Subramanian *et al*., 2001). Owing to its long duration and high productivity, it consumes greater amount of nutrients from the soil as well as from applied fertilizers for a prolonged period. The chief consideration for increasing the growth and yield is by increasing the availability of nitrogen and potassium (Muthuvel *et al*., 1989). Thus, it is essential that the fertilizers must be applied in optimal amounts and the release of nutrients from them must be steadily prolonged to match the nutrient needs of the crop over its growth period. In almost all the turmeric growing regions, the nutritional requirements are met through application of fertilizers to the soil. Split application of nutrients, especially nitrogen and potassium was recommended to improve the yield and quality.

Turmeric transplants are produced from single bud rhizome. During their growth period, it will require more quantity of nutrients from the external source. As like that of the tissue culture plants, turmeric transplants require frequent nutrition. Though, turmeric transplants being a high value commercial crop its nutrient exploiting property and applied nutrient efficiency were not studied in detail so for. Hence, an experiment was conducted to study the effects of different levels of fertigation of N and K on fertilizer use efficiency by turmeric transplants var. CO-2.

## MATERIALS AND METHODS

A field experiment to study the effect of fertigation of N and K fertilizers on fertilizer use efficiency by turmeric transplants (*Curcuma longa* L.) var. CO-2 was carried out at the college orchard, Department of Spices and Plantation Crops, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore during the period from 2014 to 2016. The experiment was laid out in randomised block design, replicated three times. Raised beds of 25 m length, 1 m breadth, 20-25 cm height were formed and protray raised turmeric transplants of one month old having two fully opened leaves produced from single bud rhizomes were planted on first week of August in paired row system. A spacing of 45 cm between rows within a paired row, 55

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**Table 1: Influence of straight and water soluble fertilizers on leaf NPK content of turmeric transplant var. CO-2 (%) (Pooled data of two years)**

| Treatments | 30 DAP | | | 60 DAP | | | 120 DAP | | | 210 DAP | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | P | K | N | P | K | N | P | K | N | P | K |
| $T_1$ | 1.13 | 0.21 | 2.91 | 1.24 | 0.25 | 3.17 | 1.19 | 0.21 | 3.01 | 1.09 | 0.17 | 2.79 |
| $T_2$ | 1.33 | 0.28 | 3.41 | 1.42 | 0.34 | 3.62 | 1.34 | 0.31 | 3.51 | 1.28 | 0.23 | 3.31 |
| $T_3$ | 1.24 | 0.25 | 3.21 | 1.34 | 0.31 | 3.33 | 1.25 | 0.26 | 3.27 | 1.19 | 0.22 | 3.09 |
| $T_4$ | 1.20 | 0.22 | 3.01 | 1.25 | 0.28 | 3.20 | 1.22 | 0.24 | 3.10 | 1.13 | 0.19 | 2.91 |
| $T_5$ | 1.08 | 0.20 | 2.88 | 1.17 | 0.24 | 3.05 | 1.13 | 0.20 | 2.94 | 1.05 | 0.14 | 2.72 |
| $T_6$ | 1.42 | 0.30 | 3.60 | 1.51 | 0.39 | 3.73 | 1.41 | 0.35 | 3.67 | 1.32 | 0.28 | 3.44 |
| $T_7$ | 1.32 | 0.29 | 3.49 | 1.45 | 0.37 | 3.69 | 1.36 | 0.32 | 3.59 | 1.28 | 0.24 | 3.38 |
| $T_8$ | 1.27 | 0.26 | 3.26 | 1.38 | 0.32 | 3.47 | 1.29 | 0.29 | 3.38 | 1.22 | 0.22 | 3.15 |
| $T_9$ | 1.18 | 0.23 | 3.11 | 1.30 | 0.30 | 3.25 | 1.21 | 0.25 | 3.17 | 1.15 | 0.20 | 3.00 |
| **Mean** | **1.24** | **0.25** | **3.21** | **1.34** | **0.31** | **3.39** | **1.26** | **0.27** | **3.29** | **1.19** | **0.21** | **3.08** |
| **SEd** | **0.027** | **0.004** | **0.032** | **0.015** | **0.004** | **0.064** | **0.020** | **0.005** | **0.054** | **0.019** | **0.005** | **0.039** |
| **LSD (0.05)** | **0.037** | **0.009** | **0.067** | **0.032** | **0.009** | **0.135** | **0.042** | **0.010** | **0.114** | **0.040** | **0.010** | **0.083** |

**Table 2: Influence of fertigation on fertilizer use efficiency of turmeric transplants var. CO-2 (Pooled data of two years)**

| Treatments | Applied N (kg ha$^{-1}$) | Applied P (kg ha$^{-1}$) | Applied K (kg ha$^{-1}$) | Pooled mean | | |
|---|---|---|---|---|---|---|
| | | | | NUE | PUE | KUE |
| $T_1$ | 150.00 | 60.00 | 108.00 | 38.27 | 95.67 | 53.15 |
| $T_2$ | 187.50 | 60.00 | 135.00 | 36.05 | 112.67 | 50.07 |
| $T_3$ | 150.00 | 60.00 | 108.00 | 43.54 | 108.86 | 60.48 |
| $T_4$ | 112.50 | 60.00 | 81.00 | 55.69 | 104.42 | 77.35 |
| $T_5$ | 75.00 | 60.00 | 54.00 | 75.53 | 94.42 | 104.91 |
| $T_6$ | 187.50 | 60.00 | 135.00 | 42.43 | 132.58 | 58.93 |
| $T_7$ | 150.00 | 60.00 | 108.00 | 52.63 | 131.58 | 73.10 |
| $T_8$ | 112.50 | 60.00 | 81.00 | 59.24 | 111.08 | 82.28 |
| $T_9$ | 75.00 | 60.00 | 54.00 | 85.11 | 106.39 | 118.21 |

cm between two adjacent paired rows and 15 cm within each row was maintained. 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 treatments comprising of $T_1$: Control – 100% Recommended dose of NPK - 150:60:108 kg ha$^{-1}$ - through straight fertilizer *i.e.*, Urea and MOP by soil application + surface irrigation, $T_2$: Fertigation of N+K @ 125% through straight fertilizers – once in a week, $T_3$: Fertigation of N+K @ 100% through straight fertilizers – once in a week, $T_4$: Fertigation of N+K @ 75% through straight fertilizers – once in a week, $T_5$: Fertigation of N+K @ 50% through straight fertilizers – once in a week, $T_6$: Fertigation of N+K @ 125% through water soluble fertilizers – once in a week, $T_7$: Fertigation of N+K @ 100% through water soluble fertilizers – once in a week, $T_8$: Fertigation of N+K @ 75% through water soluble fertilizers – once in a week and $T_9$: Fertigation of N+K @ 50% through water soluble fertilizers – once in a week.

The fertilizers are applied through drip irrigation at weekly intervals by following the schedule by which 40 % of total N and 20 % of total K were applied from 1$^{st}$ to 4$^{th}$ weeks, 10 % of total N and 10 % of total K were applied from 5$^{th}$ to 8$^{th}$ weeks, 30 % of total N and 30 % of total K were applied from 9$^{th}$ to 17$^{th}$ weeks. The remaining quantity of 20 % N and 40 % K were applied from 18$^{th}$ to 34$^{th}$ weeks. The standard recommended cultural practices (Anon, 2013) were followed for managing the crop except for the fertigation treatments envisaged in the study. At maturity the dried above ground portion (shoot) was removed 10 days before harvest leaving below ground rhizomes so as to allow the rhizome to mature. The rhizomes were harvested by digging and the fresh rhizome yield was recorded.

Turmeric leaf samples were collected at 30, 60, 120 and 210 days after planting and dried at 55°C for 6-8 hours in a hot air oven. The third youngest leaf was used as the standard leaf for nutrient estimation (Saifudeen, 1981). The nitrogen content in the leaf on dry weight basis was estimated by Micro Kjeldal method (Humphries, 1956) and expressed in percentage. The phosphorus contents in the dried leaf samples was estimated in a triple acid extract by adopting vanadomolybdate phosphoric yellow colour method (Jackson, 1973) and expressed in percentage. The potassium contents in the dried leaf samples were estimated by reading the flame photometer values of triple acid extract (Jackson, 1973) and expressed in percentage.

For computing fertilizer use efficiency, total quantity of N, P and K applied through fertilizers was considered and it was calculated using the formula-

$$NUE = \frac{\text{Yield (kg ha}^{-1}\text{)}}{\text{Nutrients (N) applied (kg)}}$$

$$PUE = \frac{\text{Yield (kg ha}^{-1}\text{)}}{\text{Nutrients (P) applied (kg)}}$$

$$KUE = \frac{\text{Yield (kg ha}^{-1}\text{)}}{\text{Nutrients (K) applied (kg)}}$$

## RESULTS AND DISCUSSION

### Leaf nutrient content

N and K fertigation rates seemed to have clear effect on leaf's nutrient (N, P and K) contents as noticed from the comparisons listed in Table 1. The leaf nutrient contents increased up to 60 DAP irrespective of the treatments and then decreased.Significant effect on leaf nitrogen content was found with respect to different fertigation treatments and revealed that $T_6$ (Fertigation of N+K @ 125% through water soluble fertilizers – once in a week) registered the highest leaf nitrogen content at all the four stages of crop growth followed by $T_7$ (Fertigation of N+K @ 100% through water soluble fertilizers – once in a week). The highest leaf's P content was achieved with $T_6$ (Fertigation of N+K @ 125% through water soluble fertilizers – once in a week) and the treatment $T_5$ (Fertigation of N+K @ 50% through straight fertilizers – once in a week) registered the lowest leaf phosphorus content. Similarly the effect of different fertigation treatment was significant on theleaf potassium content. $T_6$ (Fertigation of N+K @ 125% through water soluble fertilizers – once in a week) registered the highest leaf potassium content followed by $T_7$ (Fertigation of N+K @ 100% through water soluble fertilizers – once in a week) and were on par with each other.The uptake of nitrogen, phosphorus and potassium was significantly increased with higher rate of application. Higher uptake of nutrients was attributed to better availability of nutrients which reflected in better growth and rhizome yield (Ajithkumar and Jayachandran, 2001). Response of turmeric to increased levels of fertilizers has been significant (Parthasarathy *et al*., 2010). Since turmeric is a nutrient exhaustive crop, it respond generally well to increased soil fertility levels (Subramanian *et al*., 2001). Owing to its long duration and high productivity, it consumes greater amount of nutrients from the soil as well as from applied fertilizers for a prolonged period (Rethinam *et al.*, 1994). Higher K content in the leaf was found to be associated with higher yield in ginger (Muralidharan *et al*., 1974). The higher rate of N application might have increased the nitrogen absorption by increasing the nutrient concentration in soil (Gill *et al*., 2001).

### Fertilizer use efficiency

Feritilzer use efficiency calculated as kg dry rhizome per kg of nutrient applied are presented in table 3. When the fertilizer use efficiency (FUE) was computed it was clearly revealed that the fertigation treatments were more efficient than the conventional method of fertilizer application through soil. Fertigation of N+K @ 50% through water soluble fertilizers – once in a week ($T_9$) recorded the highest overall mean nitrogen use efficiency of 85.11kg cured rhizome per kg of nitrogen. It was followed by fertigation of N+K @ 50% through straight fertilizers – once in a week ($T_5$) (75.53 kg cured rhizome per kg N).

The phosphorus use efficiency of turmeric transplants ranged from 94.42 kg cured rhizome per kg of $P_2O_5$ to 132.58 kg cured rhizome per kg of $P_2O_5$ applied. The phosphorus use efficiency was higher in the treatment $T_6$ (132.58 kg cured rhizome per kg of $P_2O_5$) (Fertigation of N+K @ 125% through water soluble fertilizers – once in a week) followed by $T_7$ (131.58 kg cured rhizome per kg of $P_2O_5$) (Fertigation of N+K @ 100% through water soluble fertilizers – once in a week) and $T_2$ (112.67 kg cured rhizome per kg of $P_2O_5$) (Fertigation of N+K @ 125% through straight fertilizers – once in a week). However, the treatment $T_5$ (Fertigation of N+K @ 50% through straight fertilizers – once in a week) recorded the least phosphorus use efficiency of 94.42 kg cured rhizome per kg of $P_2O_5$ applied as basal dose.

The potassium use efficiency of turmeric transplants ranged from 50.07 kg cured rhizome per kg of $K_2O$ to 118.21 kg cured rhizome per kg of $K_2O$ applied. Fertigation of N+K @ 50% through water soluble fertilizers – once in a week ($T_9$) recorded the highest mean potassium use efficiency of 85.11 kg cured rhizome per kg of $K_2O$. It was followed by fertigation of N+K @ 50% through straight fertilizers – once in a week (75.53 kg cured rhizome per kg $K_2O$). The least potassium use efficiency was found in the treatment $T_2$ (Fertigation of N+K @ 125% through straight fertilizers – once in a week). Karthikeyan *et al*. (2009) reported uptake of K to be highest, compared to other nutrients, by spice crops. This is in close agreement with the findings of Noor *et al*. (2014). In terms of unit nutrient requirement, K is almost equal to that of N (Sadanandan and Hamza, 1998). Spice crops thus have a high demand for K which determines both yield and quality. This is especially important for turmeric which takes up large amounts of K from the soil which is removed at harvest in the rhizomes. Studies have also shown that K requirement of spices depends on the K status and dynamics in soil, the rooting pattern of different spices and varieties, and their productivity (Noor *et al*., 2014). There is an essential need for K to be supplied and maintained at optimum rates to augment production and improve quality (Sadanandan *et al*., 2002).

Fertilizer use efficiency of turmeric transplants revealed that fertigation treatments with 50% level N and K through water soluble fertilizer was significantly superior. The higher nutrient use efficiency observed under fertigation with water soluble fertilizer might be due to reduction in percolation, leaching and volatilization of nutrient losses. The higher root growth under fertigation treatments and increased uptake of nutrients are the main factors for increased fertilizer use efficiency. These findings are in line with the results of Bridgit *et al*. (2007).

Compared to straight fertilizers, the fertilizer use efficiency was higher with fertigation using water soluble fertilizers. Better availability of nutrients through water soluble fertilizer can be attributed for the improved yield and efficiency. Increased fertilizer use efficiency with low levels of fertilizers may be due to the fact that the demand of the plant is met by the available nutrient pool in the soil solution. At higher concentration, though the efficiency was less, the yield was higher as increased availability was able to meet the crop demand without hindrance (Krishnamoorthy *et al*., 2015).

Slow release of nutrients coupled with reduced losses due to volatilization and leaching have evidently enhanced nutrient uptake under fertigation system. Unlike surface irrigation and conventional fertilizer application, fertigation makes uniform distribution of nutrient solution in the root zone and thereby increases the fertilizer use efficiency, since the uptake of nutrients by the plant roots depends on their availability to the root system. It enhanced the overall root activity, improved the mobility of nutritive elements and their uptake.

## REFERENCES


Ajithkumar, K. and Jayachandran, B.K. 2001. Effect of major nutrients on yield of ginger (*Zingiber officinale* Rosc.) intercropped in coconut garden. *J. Spices Aromatic Crops*,**10**(1): 17-23.

Anonymous. 2013. *Crop Production Techniques of Horticultural Crops*. Horticultural College and Research Institute, TNAU, Coimbatore, Tamil Nadu, pp: 163-65.

Bridgit, T.K., Visalakshi, K.P., Sasidharan, N.K. and Mathew, R. 2007. Stress management in bhendi by fertigation through KAU micro sprinkler. *Proc. 3rd Int. Ground Water Conf*. 7-10 Ferb., 2007, Coimbatore, Tamil Nadu. pp: 39.

Gill, B.S., Krorya, R., Sharma, K.N. and Saini, S.S. 2001.Effect of rate and time of nitrogen application on growth and yield of turmeric (*Curcuma longa* L.). *J. Spices Aromatic Crops*, **10**(2): 123-26

Humphries, K.C. 1956. Mineral components and analysis. In. *Modern Methods of Plant Analysis* (Eds.) Paech, K. and Tracy, M.O., Springer Verlag, Berlin, pp. 468-502

Indiastat. 2016. Area, production and productivity of turmeric in India (1950-1951 to 2015-2016: 1st Advance Estimates). http://www.indiastat.com

Jackson, M.L. 1973. *Soil Chemical Analysis*. 2nd ed. Prentice Hall of India Pvt. Ltd., New Delhi.

Jagadeeswaran, R., Murugappan, V. and Govindaswamy, M. 2005. Effect of slow release NPK fertilizer sources on the nutrient use efficiency in turmeric (*Curcuma longa* L.). *World J. Agric. Sci.*, **1**(1): 65-69

Karthikeyan, P.K., Ravichandran, M., Imas, P. and Assaraf, M. 2009.The Effect of potassium on the yield and quality of turmeric (*Curcuma longa* L.). *e-ifc*, **2**(1) : 2-5

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. *Int. J. Agric. Sci. Res.*, **5**(1) : 67-72.

Muralidharan, A., Varma, A.S. and Nair, E.V.G. 1974. Effect of nitrogen, phosphorus and potash on growth and yield of ginger (*Zingiber officinale* Rosc.). *Indian J. Agron.*, **19**(1) : 103-04.

Muthuvel, P., Rajkannan, B., Selvaraj, K.V., Kulandaivelu, R. and Chamy, A. 1989. Irrigation, nitrogen and potash requirement of turmeric. *South Indian Hort.*, **37**(1) : 61-63.

Noor, S., Akhter, S., Islam, M.S., Hasan, T. and Hamidullah, A.T.M. 2014.Response of turmeric (*Curcuma longa* L.) to potassium fertilization on K deficient soil in Northern Bangladesh. *e-ifc*, **37**(1) : 3-9.

Parthasarathy, V.A., Dinesh, R., Srinivasan, V. and Hamza, S. 2010.Integrated nutrient management in major spices. *Indian J. Fert.*, **6**(1) : 110-28.

Rethinam, P., Edison, S., Sadanandan, A.K. and Johny, A.K. 1994. Major achievements of AICRP on spices. *Indian Cocoa, Arecanut Spices J.*, **18**(1): 16-21.

Sadanandan, A.K. and Hamza, S. 1998. Organic farming on yield and quality of spices in India. *Proc. 16th World Cong. on Soil Sci.*, 20-22 August, 1998, Montpellier, France. pp. 738.

Sadanandan, A.K., Peter, K.V. and Hamza, S. 2002. Role of potassium nutrition in improving yield and quality of spice crops in India. In. *Potassium for Sustainable Crop Production.* (Eds.) Pasricha, N.S. and Bansal, S.K., Potash Research Institute of India, Gurgaon, pp. 445-454.

Saifudeen, N. 1981. Foliar diagnosis, yield and quality of turmeric (*Curcuma longa* L.) in relation to nitrogen, phosphorus and potassium. *M.Sc (Ag) Thesis*, Kerala Agricultural University, Thrissur, Kerala, pp. 105-12.

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