Drip Fertigation’s Effect on Nutrient Contents of Chili (Capsicum annuum)

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A field experiment on nutrient contents like N, P, K and micro nutrient of chilli (capsicum annuum. L) cv. KKM-1 under drip fertigation was carried out at Madurai, Tamil Nadu during kharif and summer. The experiments were laid out in Randomized Block Design (RBD) with nine treatments in three replications. The study revealed that the increased nutrient content was obtained in T9 (T5 + liquid biofertilizers + Panchagavya + Humic acid) for both kharif and summer season. Application of 100 per cent drip fertigation through water soluble fertilizers along with bio stimulants T9 significantly higher N content (4.4 and 4.1% at 60 DAT), P (0.48 and 0.45% at 60 DAT), K (5.0 and 4.3% at 60 DAT), Ca (0.43 and 0.42% at 60 DAT), Mg (1.5 and 1.5% at 60 DAT), Zn (45.1 and 44.6 ppm at 60 DAT) Cu (20.7 and 20.4 ppm at 60 DAT) and Fe (260.4 and 259.5 ppm at 60 DAT) in both kharif and summer seasons.

K e y w o r d s
Drip Fertigation, Nutrient contents and micro nutrients, Chili

Introduction

Chilli (Capsicum annuum L.) is a spice cum vegetable crop belongs to the family Solanaceae. Chillies are nature’s wonder. The fruits appear in different sizes, shapes and colours. Chillies have two important qualities, they have biting pungency attributed to capsaicin and captivating red colour due to the pigment capsanthin. Capsaicin is a digestive stimulant, prevents heart diseases and curative for many rheumatic troubles.

Application of water soluble fertilizers through drip irrigation system is gaining importance in present day agriculture to boost the production and productivity of various crops. However, the cost of water soluble fertilizer is very high which restricts the use of fertigation, it is essential to explore the possibility of using normal fertilizer in drip fertigation. Further, Chilli crop requires a balanced fertilizer management for normal growth and development of the crop. It is a heavy feeder of nutrients and high yield can be sustained only through the application of nutrients at optimum doses in balanced proportion. The nutrient requirement also varies with the growth stages of the crop. Among the various factors responsible for higher yield, the use of appropriate quantity of fertilizer at proper time plays a vital role in enhancing the productivity. Hence, planning the nutrient supply to the physiological stages
of growth development, and considering the soil and climatic characteristics result in high yields with quality produces. Proper scheduling must be planned to provide nutrients at a time when it required by plants. This paves the way to undertake this study by adopting integrated approaches like application of inorganic fertilizers in combination with bio stimulants like liquid biofertilizers, panchagavya and humic acid under drip fertigation on nutrient contents like N, P, K, Ca, Mg, Zn, Cu and Fe in chilli.

**Materials and Methods**

The experiments were conducted at the College Orchard, Agricultural College and Research Institute, Madurai. The farm is geographically situated at 9°54′ N latitude and 78°54′ E longitude with an altitude of 147 meters above mean sea level. The cropping period of first crop (kharif), i.e., from June to December 2007 and the second experiment was carried out during summer (January – May, 2008). The experiment was laid out in Randomized Block Design with nine treatments replicated thrice with plot size of 45 m² (10 m x 4.5 m). After uniform leveling, beds were formed at a distance of 1.5 m and plants were transplanted uniformly with a spacing of 60 / 90 cm between two pairs 45 cm between plants were followed.

The recommended dose of 120: 60: 30 kg NPK ha⁻¹ was applied in the experimental plots. Fertigation was scheduled once in three days starting from second week after planting. The fertigation scheduling was planned to meet the crops demand and requirement of the nutrients at different stages of crop growth. Monoammonium phosphate, polyfeed and potassium nitrate of imported grade with water soluble solid fertilizers were used. Urea, Single Super Phosphate and muriate of potash were given as normal fertilizers.

Standard culture operation and necessary crop protection measures were followed during cropping period as per horticulture crop production guide. The data obtained from present investigation were subjected to statistical scrutiny by adopting standard procedure as described by Panse and Sukhatme (1985) and the results were interpreted.

**Treatment details**

- T₁ = RDF through soil application (120: 60: 30 kg NPK ha⁻¹)
- T₂ = 75% RDF as Urea + DAP (as basal) + KCl
- T₃ = 75 % RDF as Water Soluble Fertilizers
- T₄ = 100 % RDF as Urea + DAP (as basal) + KCl
- T₅ = 100 % RDF Water Soluble Fertilizers
- T₆ = T₂+ liquid biofertilizers + Panchagavya + Humic acid
- T₇ = T₃ + liquid biofertilizers + Panchagavya + Humic acid
- T₈ = T₄ + liquid biofertilizers + Panchagavya + Humic acid
- T₉ = T₅ + liquid biofertilizers + Panchagavya + Humic acid

**Note:**

- Water soluble fertilizers: Poly feed (19 % N, 19% P and 19% K) MAP (12% N and 61% P) and KNO₃ (13% N and 45 % K)
- Liquid biofertilizers (200 ml /acre), Panchagavya (10 litre/ac) and Humic acid (2 litre/ac)
Results and Discussion

The experiments were carried out to find the optimum level of fertigation for higher yield besides quality in chilli. The N, P, K, Ca, Mg, Cu, Zn and Fe contents in plant were estimated (Tables 1–8). Among the macronutrients, nitrogen encourages vegetative growth and imparts deep green colour to the leaves. In the present investigation, application of 100 per cent water soluble fertilizer along with bio stimulants under fertigation system showed higher nitrogen content in plant.

The presence of some macro and micro nutrients besides total reducing (glucose) sugars in panchagavya. Chemolitho autotrophic nitrifiers (ammonifiers and nitrifiers) in panchagavya increase the ammonia uptake and enhances total N supply (Papen et al., 2002). This was supported by the studies made by Kanimozhi (2004) in Coleus forskohlii.

Increase in plant nitrogen content due to liquid bio stimulants like Azospirillum inoculation has been observed by several workers in several crops (Christiansen Weniger, 1988; Singleton et al., 2002) (Table 1). In this study also the N content of chilli was increased due to the inoculation of Azospirillum and the higher content was obtained with liquid formulation. Since plants inoculated with Azospirillum had maximum N content, it is reasonable to think that the inoculation might have enhanced ‘N’ uptake by the plants due to increased availability of N in the rhizosphere by the activity of the inoculated bacteria. The present result is in agreement with Rao and Rao (1983) wherein they found increased nitrogen content in paddy due to Azospirillum inoculation.

Table 1 Effect of fertigation on N content (%) at different crop growth stages of chillies cv. KKM-1

| Treatments | Kharif  | Summer |
|------------|---------|--------|
|            | 60DAT   | 90DAT  | 120DAT | 180DAT | 60DAT  | 90DAT  | 120DAT | 180DAT |
| T1         | 3.25    | 3.18   | 3.11   | 2.91   | 3.19   | 3.12   | 3.08   | 2.78   |
| T2         | 3.37    | 3.31   | 3.24   | 3.04   | 3.26   | 3.21   | 3.16   | 2.83   |
| T3         | 3.75    | 3.68   | 3.61   | 3.10   | 3.45   | 3.39   | 3.33   | 2.95   |
| T4         | 3.63    | 3.57   | 3.49   | 2.98   | 3.31   | 3.25   | 3.18   | 2.89   |
| T5         | 3.98    | 3.93   | 3.86   | 3.35   | 3.83   | 3.79   | 3.72   | 3.20   |
| T6         | 3.86    | 3.80   | 3.72   | 3.21   | 3.75   | 3.68   | 3.64   | 3.09   |
| T7         | 4.29    | 4.24   | 4.17   | 3.67   | 4.09   | 4.04   | 3.98   | 3.41   |
| T8         | 4.15    | 4.09   | 4.02   | 3.49   | 3.97   | 3.93   | 3.89   | 3.30   |
| T9         | 4.38    | 4.33   | 4.26   | 3.91   | 4.14   | 4.10   | 4.06   | 3.53   |
| SEd        | 0.084   | 0.086  | 0.086  | 0.073  | 0.079  | 0.081  | 0.082  | 0.058  |
| CD(p=0.05) | 0.179   | 0.182  | 0.182  | 0.155  | 0.169  | 0.17   | 0.174  | 0.123  |
Table 2 Effect of fertigation on P content (%) at different crop growth stages of chillies cv. KKM-1

| Treatments | Kharif | Summer |
|------------|--------|--------|
|            | 60DAT  | 90DAT  | 120DAT | 180DAT | 60DAT  | 90DAT  | 120DAT | 180DAT |
| T1         | 0.301  | 0.286  | 0.255  | 0.234  | 0.292  | 0.277  | 0.242  | 0.220  |
| T2         | 0.339  | 0.324  | 0.292  | 0.279  | 0.297  | 0.282  | 0.247  | 0.261  |
| T3         | 0.381  | 0.367  | 0.335  | 0.323  | 0.343  | 0.328  | 0.296  | 0.308  |
| T4         | 0.355  | 0.338  | 0.307  | 0.301  | 0.328  | 0.313  | 0.280  | 0.294  |
| T5         | 0.416  | 0.401  | 0.371  | 0.354  | 0.389  | 0.374  | 0.343  | 0.330  |
| T6         | 0.397  | 0.381  | 0.349  | 0.330  | 0.357  | 0.342  | 0.307  | 0.319  |
| T7         | 0.455  | 0.447  | 0.418  | 0.369  | 0.439  | 0.422  | 0.388  | 0.340  |
| T8         | 0.431  | 0.421  | 0.390  | 0.357  | 0.423  | 0.410  | 0.375  | 0.337  |
| T9         | 0.479  | 0.466  | 0.439  | 0.395  | 0.451  | 0.438  | 0.403  | 0.355  |
| SEd        | 0.0124 | 0.0128 | 0.0130 | 0.011  | 0.0129 | 0.0130 | 0.0130 | 0.009  |
| CD(p=0.05) | 0.0262 | 0.0270 | 0.0276 | 0.023  | 0.0274 | 0.0275 | 0.0275 | 0.020  |

Table 3 Effect of fertigation on K content (%) at different crop growth stages of chillies cv. KKM-1

| Treatments | Kharif | Summer |
|------------|--------|--------|
|            | 60DAT  | 90DAT  | 120DAT | 180DAT | 60DAT  | 90DAT  | 120DAT | 180DAT |
| T1         | 3.61   | 3.49   | 3.33   | 3.07   | 3.47   | 3.36   | 3.21   | 2.99   |
| T2         | 3.87   | 3.76   | 3.66   | 3.29   | 3.51   | 3.45   | 3.34   | 3.11   |
| T3         | 4.43   | 4.33   | 4.21   | 3.65   | 3.73   | 3.64   | 3.57   | 3.37   |
| T4         | 4.38   | 4.27   | 4.15   | 3.48   | 3.67   | 3.59   | 3.51   | 3.2    |
| T5         | 4.69   | 4.58   | 4.47   | 3.80   | 4.13   | 4.07   | 3.99   | 3.54   |
| T6         | 4.58   | 4.47   | 4.35   | 3.69   | 4.10   | 3.92   | 3.84   | 3.41   |
| T7         | 4.91   | 4.80   | 4.69   | 4.17   | 4.24   | 4.17   | 4.10   | 3.90   |
| T8         | 4.74   | 4.63   | 4.52   | 3.98   | 4.19   | 4.11   | 4.02   | 3.77   |
| T9         | 5.04   | 4.94   | 4.88   | 4.29   | 4.31   | 4.26   | 4.18   | 4.05   |
| SEd        | 0.104  | 0.102  | 0.103  | 0.086  | 0.071  | 0.072  | 0.076  | 0.079  |
| CD(p=0.05) | 0.214  | 0.216  | 0.219  | 0.183  | 0.151  | 0.153  | 0.161  | 0.167  |

Table 4 Effect of fertigation on Ca content (%) at different crop growth stages of chillies cv. KKM-1

| Treatments | Kharif | Summer |
|------------|--------|--------|
|            | 60DAT  | 90DAT  | 120DAT | 180DAT | 60DAT  | 90DAT  | 120DAT | 180DAT |
| T1         | 0.253  | 0.234  | 0.213  | 0.199  | 0.229  | 0.210  | 0.188  | 0.178  |
| T2         | 0.265  | 0.251  | 0.230  | 0.201  | 0.250  | 0.233  | 0.214  | 0.194  |
| T3         | 0.298  | 0.283  | 0.264  | 0.229  | 0.287  | 0.268  | 0.249  | 0.213  |
| T4         | 0.278  | 0.265  | 0.243  | 0.221  | 0.274  | 0.255  | 0.236  | 0.200  |
| T5         | 0.387  | 0.376  | 0.357  | 0.322  | 0.353  | 0.336  | 0.318  | 0.282  |
| T6         | 0.363  | 0.349  | 0.330  | 0.295  | 0.339  | 0.320  | 0.301  | 0.265  |
| T7         | 0.419  | 0.408  | 0.389  | 0.361  | 0.398  | 0.379  | 0.362  | 0.329  |
| T8         | 0.411  | 0.399  | 0.380  | 0.345  | 0.402  | 0.384  | 0.366  | 0.331  |
| T9         | 0.431  | 0.419  | 0.402  | 0.373  | 0.418  | 0.401  | 0.383  | 0.353  |
| SEd        | 0.015  | 0.015  | 0.016  | 0.015  | 0.015  | 0.015  | 0.015  | 0.014  |
| CD(p=0.05) | 0.032  | 0.033  | 0.034  | 0.033  | 0.032  | 0.032  | 0.032  | 0.030  |
**Table 5** Effect of fertigation on Mg content (%) at different crop growth stages of chillies cv. KKM-1

| Treatments | Kharif   | Summer   |
|------------|----------|----------|
|            | 60DAT    | 90DAT    | 120DAT   | 180DAT   | 60DAT    | 90DAT    | 120DAT   | 180DAT   |
| T1         | 1.21     | 1.16     | 1.07     | 0.97     | 1.19     | 1.08     | 0.95     | 0.88     |
| T2         | 1.36     | 1.30     | 1.21     | 1.08     | 1.25     | 1.19     | 1.10     | 0.96     |
| T3         | 1.29     | 1.23     | 1.14     | 1.05     | 1.34     | 1.28     | 1.19     | 1.11     |
| T4         | 1.38     | 1.31     | 1.26     | 1.10     | 1.29     | 1.23     | 1.14     | 1.03     |
| T5         | 1.43     | 1.38     | 1.31     | 1.22     | 1.38     | 1.33     | 1.25     | 1.15     |
| T6         | 1.41     | 1.35     | 1.27     | 1.14     | 1.35     | 1.29     | 1.21     | 1.07     |
| T7         | 1.49     | 1.43     | 1.35     | 1.26     | 1.43     | 1.38     | 1.32     | 1.20     |
| T8         | 1.45     | 1.38     | 1.29     | 1.18     | 1.40     | 1.32     | 1.26     | 1.18     |
| T9         | 1.53     | 1.49     | 1.46     | 1.30     | 1.48     | 1.44     | 1.38     | 1.24     |
| SEd        | 0.021    | 0.021    | 0.023    | 0.022    | 0.019    | 0.023    | 0.027    | 0.025    |
| CD(p=0.05) | 0.045    | 0.046    | 0.050    | 0.048    | 0.041    | 0.048    | 0.058    | 0.054    |

**Table 6** Effect of fertigation on Zn (ppm) at different crop growth stages of chillies cv. KKM-1

| Treatments | Kharif   | Summer   |
|------------|----------|----------|
|            | 60DAT    | 90DAT    | 120DAT   | 180DAT   | 60DAT    | 90DAT    | 120DAT   | 180DAT   |
| T1         | 43.18    | 42.74    | 40.21    | 36.04    | 42.37    | 42.01    | 39.53    | 35.10    |
| T2         | 43.52    | 43.29    | 40.93    | 36.67    | 42.81    | 42.47    | 40.01    | 35.39    |
| T3         | 44.28    | 44.01    | 41.54    | 37.25    | 43.74    | 43.42    | 41.04    | 35.81    |
| T4         | 43.81    | 43.55    | 41.12    | 36.88    | 43.37    | 43.03    | 40.58    | 35.47    |
| T5         | 44.60    | 44.37    | 42.09    | 37.99    | 44.12    | 43.82    | 41.43    | 36.60    |
| T6         | 44.45    | 44.08    | 41.72    | 37.34    | 43.92    | 43.64    | 41.25    | 36.29    |
| T7         | 44.87    | 44.61    | 42.15    | 38.45    | 44.43    | 44.16    | 41.80    | 37.18    |
| T8         | 44.75    | 44.40    | 41.89    | 38.11    | 44.27    | 43.99    | 41.59    | 36.99    |
| T9         | 45.11    | 44.78    | 42.41    | 38.96    | 44.61    | 44.35    | 41.97    | 37.66    |
| SEd        | 0.140    | 0.144    | 0.150    | 0.201    | 0.163    | 0.170    | 0.179    | 0.193    |
| CD(p=0.05) | 0.298    | 0.306    | 0.319    | 0.426    | 0.346    | 0.361    | 0.379    | 0.409    |

**Table 7** Effect of fertigation on Cu (ppm) at different crop growth stages of chillies cv. KKM-1

| Treatments | Kharif   | Summer   |
|------------|----------|----------|
|            | 60DAT    | 90DAT    | 120DAT   | 180DAT   | 60DAT    | 90DAT    | 120DAT   | 180DAT   |
| T1         | 19.47    | 17.98    | 15.19    | 13.77    | 19.33    | 18.02    | 15.23    | 13.59    |
| T2         | 19.61    | 18.14    | 15.38    | 14.09    | 19.47    | 18.12    | 15.31    | 13.71    |
| T3         | 19.93    | 18.47    | 15.76    | 14.15    | 19.61    | 18.26    | 15.43    | 14.01    |
| T4         | 19.75    | 18.30    | 15.57    | 13.98    | 19.53    | 18.17    | 15.35    | 13.87    |
| T5         | 20.01    | 18.65    | 16.11    | 14.35    | 19.89    | 18.45    | 15.68    | 14.19    |
| T6         | 19.97    | 18.58    | 15.93    | 14.21    | 19.81    | 18.39    | 15.59    | 13.98    |
| T7         | 20.48    | 19.13    | 16.57    | 15.04    | 20.06    | 18.57    | 15.81    | 14.49    |
| T8         | 20.29    | 18.95    | 16.31    | 14.93    | 19.97    | 18.49    | 15.73    | 14.27    |
| T9         | 20.67    | 19.36    | 16.77    | 15.19    | 20.35    | 18.81    | 15.96    | 14.63    |
| SEd        | 0.085    | 0.099    | 0.115    | 0.110    | 0.070    | 0.053    | 0.053    | 0.074    |
| CD(p=0.05) | 0.181    | 0.210    | 0.245    | 0.233    | 0.148    | 0.113    | 0.114    | 0.158    |
Table. 8 Effect of fertigation on Fe (ppm) at different crop growth stages of chillies cv. KKM-1

| Treatments | Kharif 60DAT | Kharif 90DAT | Kharif 120DAT | Kharif 180DAT | Summer 60DAT | Summer 90DAT | Summer 120DAT | Summer 180DAT |
|------------|--------------|--------------|---------------|---------------|--------------|--------------|---------------|---------------|
| T1         | 247.29       | 240.52       | 231.79        | 211.04        | 245.81       | 238.79       | 229.66        | 208.27        |
| T2         | 249.97       | 243.18       | 234.42        | 216.35        | 247.43       | 240.52       | 231.53        | 212.30        |
| T3         | 254.41       | 248.55       | 239.70        | 225.17        | 251.58       | 244.75       | 235.82        | 219.73        |
| T4         | 251.81       | 244.15       | 236.63        | 220.03        | 249.47       | 242.62       | 233.78        | 215.18        |
| T5         | 257.98       | 251.07       | 245.19        | 226.11        | 255.25       | 249.21       | 240.50        | 222.47        |
| T6         | 256.67       | 249.79       | 242.85        | 223.47        | 254.97       | 248.38       | 239.61        | 219.61        |
| T7         | 258.34       | 253.51       | 247.37        | 231.19        | 257.69       | 251.87       | 243.17        | 227.34        |
| T8         | 257.64       | 251.94       | 245.94        | 229.07        | 255.81       | 250.64       | 241.95        | 224.68        |
| T9         | 260.41       | 255.55       | 249.07        | 234.32        | 259.47       | 254.39       | 246.83        | 230.15        |
| SEd        | 0.948        | 1.094        | 1.319         | 1.587         | 1.018        | 1.162        | 1.238         | 1.537         |
| CD(p=0.05) | 2.011        | 2.320        | 2.796         | 3.366         | 2.159        | 2.464        | 2.626         | 3.259         |

Phosphorus plays key role in the plants energy transfer system (Table 2). The present study, relatively maximum phosphorus content in plant was noticed with application of 100 per cent water soluble fertilizer along with bio stimulants. This finding is in accordance with Papadopoulos (1992) in potato cv. Spunta.

Potassium, being a protoplasmic factor is an essential plant nutrient. Many enzymes are activated by potassium and potassium is also involved in photo and oxidative phosphorylation thus augmenting the energy required for fruit growth. Drip fertigation with 100 per cent water soluble fertilizers along with bio stimulants enhanced the absorption of potassium in both the seasons of crop growth. Fontes et al., (2000) opined that application of N and K in combination with drip irrigation increased the yield by the way of maximizing the mobility of the nutrients around the root zone (Table 3). These results are in agreement with those obtained by El-Gizawy (1993) and Kavitha (2005) in tomato. The potassium content in the chilli plant exerted a similar pattern as that in the case of nitrogen and phosphorus. The transformation reactions that took place led to greater availability of potassium in the soil and consequently resulted in the better utilization by the plant. It is also possible that the fertigation combined with water soluble fertilizer might have activated the physiological processes for the rapid absorption and utilization of the nutrient for the primary metabolic processes. Similar findings were reported by Ghanta and Mitra (1993) and Singh et al., (1995).

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How to cite this article:

Ciba, C. and Syamala, M. 2017. Drip Fertigation’s Effect on Nutrient Contents of Chiili (Capsicum annuum). Int. J. Curr. Microbiol. App. Sci. 6(11): 3314-3320.

doi: https://doi.org/10.20546/ijemas.2017.611.388