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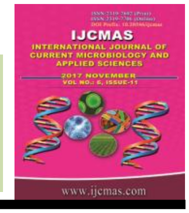

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Drip Fertigation's Effect on Nutrient Contents of Chiili (*Capsicum annuum*)

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A B S T R A C T

A field experiment on nutrient contents like N, P, K and micro nutrient of chiili (*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 T_9 (T_5 + 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 T_9 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.

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 m^2 (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

T_1 = RDF through soil application (120: 60: 30 kg NPK ha^{-1})

T_2 = 75% RDF as Urea + DAP (as basal) + KCl

T_3 = 75 % RDF as Water Soluble Fertilizers

T_4 = 100 % RDF as Urea + DAP (as basal) + KCl

T_5 = 100 % RDF Water Soluble Fertilizers

T_6 = T_2+ liquid biofertilizers + Panchagavya + Humic acid

T_7 = T_3 + liquid biofertilizers + Panchagavya + Humic acid

T_8 = T_4 + liquid biofertilizers + Panchagavya + Humic acid

T_9 = T_5 + 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 KNO_3 (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
T_1	3.25	3.18	3.11	2.91	3.19	3.12	3.08	2.78
T_2	3.37	3.31	3.24	3.04	3.26	3.21	3.16	2.83
T_3	3.75	3.68	3.61	3.10	3.45	3.39	3.33	2.95
T_4	3.63	3.57	3.49	2.98	3.31	3.25	3.18	2.89
T_5	3.98	3.93	3.86	3.35	3.83	3.79	3.72	3.20
T_6	3.86	3.80	3.72	3.21	3.75	3.68	3.64	3.09
T_7	4.29	4.24	4.17	3.67	4.09	4.04	3.98	3.41
T_8	4.15	4.09	4.02	3.49	3.97	3.93	3.89	3.30
T_9	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**
T_1	0.301	0.286	0.255	0.234	0.292	0.277	0.242	0.220
T_2	0.339	0.324	0.292	0.279	0.297	0.282	0.247	0.261
T_3	0.381	0.367	0.335	0.323	0.343	0.328	0.296	0.308
T_4	0.355	0.338	0.307	0.301	0.328	0.313	0.280	0.294
T_5	0.416	0.401	0.371	0.354	0.389	0.374	0.343	0.330
T_6	0.397	0.381	0.349	0.330	0.357	0.342	0.307	0.319
T_7	0.455	0.447	0.418	0.369	0.439	0.422	0.388	0.340
T_8	0.431	0.421	0.390	0.357	0.423	0.410	0.375	0.337
T_9	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**
T_1	3.61	3.49	3.33	3.07	3.47	3.36	3.21	2.99
T_2	3.87	3.76	3.66	3.29	3.51	3.45	3.34	3.11
T_3	4.43	4.33	4.21	3.65	3.73	3.64	3.57	3.37
T_4	4.38	4.27	4.15	3.48	3.67	3.59	3.51	3.2
T_5	4.69	4.58	4.47	3.80	4.13	4.07	3.99	3.54
T_6	4.58	4.47	4.35	3.69	4.10	3.92	3.84	3.41
T_7	4.91	4.80	4.69	4.17	4.24	4.17	4.10	3.90
T_8	4.74	4.63	4.52	3.98	4.19	4.11	4.02	3.77
T_9	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**
T_1	0.253	0.234	0.213	0.199	0.229	0.210	0.188	0.178
T_2	0.265	0.251	0.230	0.201	0.250	0.233	0.214	0.194
T_3	0.298	0.283	0.264	0.229	0.287	0.268	0.249	0.213
T_4	0.278	0.265	0.243	0.221	0.274	0.255	0.236	0.200
T_5	0.387	0.376	0.357	0.322	0.353	0.336	0.318	0.282
T_6	0.363	0.349	0.330	0.295	0.339	0.320	0.301	0.265
T_7	0.419	0.408	0.389	0.361	0.398	0.379	0.362	0.329
T_8	0.411	0.399	0.380	0.345	0.402	0.384	0.366	0.331
T_9	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
T_1	1.21	1.16	1.07	0.97	1.19	1.08	0.95	0.88
T_2	1.36	1.30	1.21	1.08	1.25	1.19	1.10	0.96
T_3	1.29	1.23	1.14	1.05	1.34	1.28	1.19	1.11
T_4	1.38	1.31	1.26	1.10	1.29	1.23	1.14	1.03
T_5	1.43	1.38	1.31	1.22	1.38	1.33	1.25	1.15
T_6	1.41	1.35	1.27	1.14	1.35	1.29	1.21	1.07
T_7	1.49	1.43	1.35	1.26	1.43	1.38	1.32	1.20
T_8	1.45	1.38	1.29	1.18	1.40	1.32	1.26	1.18
T_9	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
T_1	43.18	42.74	40.21	36.04	42.37	42.01	39.53	35.10
T_2	43.52	43.29	40.93	36.67	42.81	42.47	40.01	35.39
T_3	44.28	44.01	41.54	37.25	43.74	43.42	41.04	35.81
T_4	43.81	43.55	41.12	36.88	43.37	43.03	40.58	35.47
T_5	44.60	44.37	42.09	37.99	44.12	43.82	41.43	36.60
T_6	44.45	44.08	41.72	37.34	43.92	43.64	41.25	36.29
T_7	44.87	44.61	42.15	38.45	44.43	44.16	41.80	37.18
T_8	44.75	44.40	41.89	38.11	44.27	43.99	41.59	36.99
T_9	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
T_1	19.47	17.98	15.19	13.77	19.33	18.02	15.23	13.59
T_2	19.61	18.14	15.38	14.09	19.47	18.12	15.31	13.71
T_3	19.93	18.47	15.76	14.15	19.61	18.26	15.43	14.01
T_4	19.75	18.30	15.57	13.98	19.53	18.17	15.35	13.87
T_5	20.01	18.65	16.11	14.35	19.89	18.45	15.68	14.19
T_6	19.97	18.58	15.93	14.21	19.81	18.39	15.59	13.98
T_7	20.48	19.13	16.57	15.04	20.06	18.57	15.81	14.49
T_8	20.29	18.95	16.31	14.93	19.97	18.49	15.73	14.27
T_9	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*				Summer			
	60DAT	90DAT	120DAT	180DAT	60DAT	90DAT	120DAT	180DAT
T_1	247.29	240.52	231.79	211.04	245.81	238.79	229.66	208.27
T_2	249.97	243.18	234.42	216.35	247.43	240.52	231.53	212.30
T_3	254.41	248.55	239.70	225.17	251.58	244.75	235.82	219.73
T_4	251.81	244.15	236.63	220.03	249.47	242.62	233.78	215.18
T_5	257.98	251.07	245.19	226.11	255.25	249.21	240.50	222.47
T_6	256.67	249.79	242.85	223.47	254.97	248.38	239.61	219.61
T_7	258.34	253.51	247.37	231.19	257.69	251.87	243.17	227.34
T_8	257.64	251.94	245.94	229.07	255.81	250.64	241.95	224.68
T_9	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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