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Impact of drip fertigation on leaf nutrient status and yield attributes in chilli (*Capsicum annuum* L.) Hybrid CCH1

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ABSTRACT : A field experiment to study the soil, plant nutrient status and yield of hybrid chilli (*Capsicum annuum* L.) CCH1 as influenced by fertigation of N and K fertilizers was carried out during 2010-12. The experiment was laid out in Randomized Block Design with three replications and the treatments included were three levels (125, 100 and 75 % recommended dose) each of water soluble and straight fertilizers. The soil nutrient parameters *viz.*, available soil nitrogen, phosphorus, potassium content and plant nutrient parameters *viz*., leaf nitrogen, phosphorus and potassium were recorded. The yield parameters like number of fruits per plant, fruit girth, and fruit weight, green fruit yield per plant and per plot were also recorded. The study revealed that the soil and plant nutrient contents in general increased up to 120 days and then declined. Among the several treatments, NPK @ 100 per cent recommended dose of water soluble fertilizers along with liquid biofertilizers registered the highest value for the soil, plant nutrient content and yield parameters.

KEY WORDS : Fertigation, Soil, Leaf nutrients, Water soluble fertilizers, Straight fertilizers, Yield

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Chilli (*Capsicum annuum* L.) is one the most important commercial crops of India. It is grown almost throughout the country. There are more than 400 different varieties of chillies found all over the world. It is also called as hot pepper, cayenne pepper, sweet pepper, bell pepper, etc. The world's hottest chilli "Naga Jolokia" is cultivated in hilly terrain of Assam. It is an important spice-cum-vegetable crop grown in many parts of the world, which is actually a fruit pod from the plant belonging to the nightshade family of Solanaceae. Currently, chillies are used throughout the world as a spice and also making of beverages and medicines. If some varieties of chillies are famous for red colour because of the pigment 'capsanthin,' others are known for biting pungency attributed to the pigment 'capsaicin.' India is the only country which is rich in many varieties with different quality factors. Chillies are rich in vitamins, especially in vitamin A and C. They are also packed with potassium, magnesium and iron. Chillies have long been used for pain relief as they are known to inhibit pain messengers, extracts of chilli pepper are used for alleviating the pain of arthritis, headaches, burns and neuralgia. It is also claimed that they have power to boost immune system and lower cholesterol. They are also helpful in getting rid of parasites of gut.

Nutrient management is the most important agrotechnique, which controls growth, yield and quality of a crop. Nutrient use efficiency is only 50 per cent in conventional practices of soil application. Sustainability of any system requires optimal utilization of resources such as water, fertilizers and soil. Apart from the economic considerations, the adverse effect of injudicious use of water and fertilizers on the environment can have far reaching implications. However, proper fertigation management also requires the knowledge of soil fertility status and nutrient uptake by the crop. Monitoring soil and plant nutrient status is an essential safeguard to ensure favourable growing condition with maximum crop characteristics and nutrient uptake (Mmolawa and Or, 2000). Hence, it is essential to explore the impact of fertigation on soil fertility status and nutrient uptake by chilli to optimize fertilizer use.

Drip fertigation on application of fertilizer through drip irrigation has been found to dramatically improve the yield and quality of many horticultural crops. Enhancement of yield and quality of various crops has been reported by using water soluble fertilizers in fertigation (Hebbar *et al*., 2004). Hence, the study was taken up in hybrid chilli CCH1 with the objective of studying the impact of drip fertigation in the soil, plant nutrient status and yield in chilli hybrid.

RESEARCH METHODS

Field experiments were carried out to standardize nutrient requirements for chilli 'TNAU Chilli Hybrid CO 1' under drip fertigation system in open field cultivation in farmer's field at Thalampallam village in Dharmapuri district during 2010-11. The study encompasses comparative analysis of growth, physiology, nutritional and production changes of chilli under fertigation and conventional systems. The details of materials used and methods employed in the study are described. The experiment was laid out in a Randomized Block Design with nine treatments replicated thrice. A plot size of 7.5 m^2 (7.5 m x 1.0 m) was followed for each treatment. In treatments receiving fertigation, drip laterals were laid along the length of each paired row at the centre with the spacing kept 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 details of the treatments are; T_1- 125% RDF with water soluble fertilizers + liquid biofertilizer (*Azospirillum*+ Phosphobacteria), T_2 - 100% RDF with water soluble fertilizers +liquid biofertilizer, T_3 - 75% RDF with water soluble fertilizers + liquid biofertilizer, T_4 - 100 % RDF with water soluble fertilizers, T_5-125 % RDF with straight fertilizers+ liquid biofertilizer, T_6 - 100 % RDF with straight fertilizers + liquid biofertilizer, T_7- 75 % RDF with straight fertilizers + liquid biofertilizer, T_8 - 100% RDF with straight fertilizers, T_9 - Control – soil application of 100% RDF with flood irrigation (RDF - Recommended dose of fertilizers – NPK @ 120:80:80 kg ha^{-1} and liquid biofertilizer (Azophosmet containing *Azospirillum*, phosphobacteria and Methylobacterium species).

The fertilizers were applied through drip irrigation at weekly intervals by following the schedule by which 50 per cent of total N and 30 per cent of total K were applied from 3rd to 9th weeks, 40 per cent of total N and 50 per cent of total K were applied from 10th to 16th week. The remaining quality of 10 per cent N and 20 per cent K were applied from 18th to 20th weeks. In all the fertigation treatments, the full dose of phosphorus (60kg ha^{-1}) was applied as basal using single super phosphate (16 % 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 90th, 120th, 150th day and the leaf samples were collected at 60th, 90th, 120th, and 150th days after planting (DAP) and the samples were analyzed as per standard procedures (Subbiah and Asija, 1956 and Hamphries, 1956).

RESEARCH FINDINGS AND DISCUSSION

The applied nutrients of 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 184.60 kg ha^{-1} (Table 1). At 90 DAS 150 DAS, the nitrogen content was more in the control (T_9) and at 150 DAS and harvest time, the N was more in the treatment T_2 (NPK @ 100 % recommended dose of water soluble fertilizers along with liquid biofertilizers). Reduced levels of soil nitrogen in fertigation treatments up to 150 DAS indicates the possibility of better uptake and utilization in the early stages of vegetative growth.

As regard to soil phosphorus content, the differences between different treatments were not significant. It should be noted that the phosphorus was applied be basal dose in all the treatments. Initially at 90 DAS, phosphorus contents were increased and then

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

Treatments	Soil nitrogen content (kg ha^{-1})					Soil phosphorus content (kg ha^{-1})				
	Initial soil N content (kg ha^{-1})	Soil N content 90 DAP (kg ha^{-1})	Soil N content 120 DAP (kg ha^{-1})	Soil N content 150 DAP (kg ha^{-1})	Soil N content 180 DAP (kg ha^{-1})	Initial soil P content (kg ha^{-1})	Soil P content 90 DAP (kg ha^{-1})	Soil P content 120 DAP (kg ha^{-1})	Soil P content 150 DAP (kg ha^{-1})	Soil P content 180 DAP (kg ha^{-1})
T_1	184.6	211.35	207.75	204.15	196.0	34.8	55.2	45.8	39.6	34.7
T_2		208.23	205.07	201.91	198.2		54.9	46.9	40.4	35.0
T_3		203.65	201.97	200.29	191.7		55.6	44.0	39.2	34.0
T_4		197.82	197.65	197.48	185.6		53.9	43.2	37.5	33.1
T_5		194.79	194.14	193.48	187.8		54.5	43.4	38.0	33.7
T_6		191.82	191.01	190.19	189.2		54.8	43.7	38.7	34.3
T_7		188.97	187.57	186.17	187.5		52.7	42.0	36.1	31.0
T_8		186.02	184.22	182.41	179.2		52.4	41.8	35.8	30.4
T_9		181.23	178.53	175.83	178.4		51.2	41.2	35.4	29.2
S.E.$\pm$		19.28	19.67	20.05	5.8		1.7	1.4	1.2	1.1
C.D. (P=0.05)		40.89	41.70	42.50	12.2		NS	NS	NS	NS

NS=Non-significant

Table 2 : Influence of straight and water soluble fertilizer on soil potassium content (kg ha^{-1})

Treatments	Initial soil K content (kg ha^{-1})	Soil K content 90 DAP (kg ha^{-1})	Soil K content 120 DAP (kg ha^{-1})	Soil K content 150 DAP (kg ha^{-1})	Soil K content 180 DAP (kg ha^{-1})
T_1	252.6	326.38	321.51	323.95	274.5
T_2		323.46	320.75	322.11	280.5
T_3		320.19	315.68	317.94	274.3
T_4		321.51	318.36	319.94	260.8
T_5		316.36	313.98	315.17	262.6
T_6		310.21	309.27	309.74	263.2
T_7		308.62	306.19	307.41	255.2
T_8		305.19	301.03	303.11	253.8
T_9		299.27	299.08	299.18	247.3
S.E.$\pm$		34.20	32.81	33.51	7.5
C.D. (P=0.05)		72.50	69.55	71.03	15.8

Table 3 : Influence of straight and water soluble fertilizer on leaf nitrogen, leaf phosphorus and leaf potassium content (%)

Treatments	Leaf nitrogen (%)				Leaf phosphorus (%)				Leaf potassium (%)			
	90 DAP	120 DAP	150 DAP	180 DAP	90 DAP	120 DAP	150 DAP	180 DAP	90 DAP	120 DAP	150 DAP	180 DAP
T_1	2.61	2.97	2.97	2.03	0.68	0.44	0.65	0.59	1.94	2.87	2.93	2.45
T_2	2.76	3.08	3.14	2.11	0.70	0.46	0.68	0.63	2.05	3.01	3.10	2.51
T_3	2.36	2.45	2.48	1.80	0.62	0.41	0.60	0.53	1.81	2.65	2.73	2.33
T_4	2.43	2.66	2.71	1.94	0.65	0.42	0.61	0.56	1.88	2.75	2.82	2.38
T_5	2.00	2.02	2.07	1.53	0.55	0.38	0.54	0.46	1.68	2.43	2.56	2.08
T_6	2.13	2.19	2.26	1.68	0.59	0.39	0.58	0.50	1.74	2.50	2.61	2.19
T_7	1.30	1.38	1.42	1.26	0.46	0.34	0.46	0.39	1.40	1.93	2.15	1.70
T_8	1.65	1.79	1.84	1.42	0.51	0.36	0.50	0.44	1.59	2.23	2.34	1.96
T_9	1.09	1.11	1.16	1.10	0.41	0.33	0.42	0.35	1.26	1.50	1.75	1.35
S.E.$\pm$	0.28	0.26	0.26	0.24	0.07	0.05	0.06	0.06	1.13	0.26	0.29	0.23
C.D. (P=0.05)	0.58	0.74	0.55	0.50	0.15	0.11	0.14	0.14	0.50	0.56	0.61	0.48

Table 4 : Yield and yield components of chilli as different treatment on drip fertigation

Treatments	Fruits plant^{-1}	Fruit girth (cm)	Fruit weight (g)	Green fruit yield per plot (kg)	Green fruit yield per hectare (t)
T_1	282.20	3.22	4.31	19.01	25.34
T_2	286.82	3.30	4.41	20.82	27.75
T_3	266.74	3.06	4.15	18.49	24.68
T_4	272.73	3.13	4.17	18.60	24.83
T_5	250.90	2.95	3.94	16.90	22.52
T_6	258.99	3.00	4.10	15.81	21.08
T_7	236.12	2.69	3.90	13.16	17.53
T_8	246.97	2.77	3.98	14.24	19.01
T_9	228.41	2.56	3.81	9.48	12.64
S.E.$\pm$	26.22	0.32	0.55	1.95	2.51
C.D. (P=0.05)	55.59	0.69	1.16	4.13	5.32

declined (Table 1). Phosphorus requirement for chilli was considered generally low (60 kg ha^{-1}) and is required in early stages. However, similar to soil N levels the soil potassium content were also lesser in fertigation treatments compared to conventional way of fertilizer application treatment T_2 recorded a potassium content of 323.46, 320.75, 322.11 and 280.5 kg ha^{-1} at 90, 120, 150 and 180 DAP (Table 2). Scheduling of N and K nutrient 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 that fertigation with straight or water soluble fertilizers especially at 75 per cent and 100 per cent levels levels improved leaf nutrient concentration.

The treatment T_2 registered significantly higher nitrogen contents in all the four stages while T_9 (Control) recorded the least. Among the different stages, the highest leaf phosphorus content was recorded at 150 DAS and was in the range of 0.70 to 0.62 per cent (Table 3). However, similar to leaf nitrogen the leaf phosphorus content where higher in the treatment T_2.

In general, the leaf potassium increased up to 150 DAS and then it declined (Table 3). Among the different treatments, T_2 registered highest leaf potassium content of 2.05 per cent (90 DAS) and 3.01 per cent (150 DAS) and 3.10 per cent (180 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 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 chilli. Among the treatments, T_2 registered significantly higher number of fruits per plant (286.82) and dry matter production. This yield increase resulted from T_2 also recorded highest length and girth of chilli fruits (3.30 cm). The highest weight of fruits (4.41 g), green fruit yield per plot (20.82 kg) and green fruit yield per hectare (27.75 t) were also recorded in T_2 (Table 4).

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 chilli quality traits. The leaf NPK levels as recorded in T_2 may be considered as bench marks for obtaining higher in chilli. 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 improvement in tomato (Deshmukh and Takte, 2007) and in onion (Muralikrishnasamy *et al*., 2006).

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