

Effect of drip fertigation under different fertilizer levels on nutrient status in coconut (*Cocos nucifera* L) leaf

ABSTRACT

A study was conducted during 2017-18 under the All India Co-ordinated Research Project initiated in 2009 at research farm of Bihar Agricultural University, Sabour, Bhagalpur. The aim of this study was compare the nutrient concentration of coconut leaves at different nutrient levels through drip fertigation. Coconut seedling was first planted in the experimental farm in 2009. Drip irrigation alongwith fertilizer application (Fertigation) was imposed on this experiment in 2012 with Urea, Diammonium phosphate, Muriate of potash in a Randomized Block Design (RBD) with four (4) replications. Result was observed that leaf Nitrogen, Phosphorous, Sulphur, Iron, Manganese, Copper and Boron content under different fertigation treatments were not significantly different from each other. All the treatments for leaf K content were significantly different. Iron, manganese, copper and boron content in coconut leaf under different treatments were significantly different. But all the treatments for Zn content were at par. The content of these micronutrients in leaf were found to increase with increasing levels of fertilizer in the treatments. Cation Exchange Capacity was positively correlated with all the leaf nutrients. Organic carbon did not show remarkable relation with plant nutrient parameters. Soil K content of all three depths was positively correlated with all the leaf nutrient elements, but more significant correlation coefficient value found with leaf micronutrients. S, Fe, Mn, Zn, Cu and B content in soil across the soil depths was negligibly correlated with the leaf nutrients elements content. Highest content of leaf N content was found in T5 treatment. Effect of all the treatments on leaf phosphorus content of coconut was also not significantly different, but the highest content was found in T6 treatment. It's content in leaf under T5 and T4 treatments were higher than T6 treatment. All the treatments for sulphur content in leaf of coconut were not significantly different but its content increases with increasing levels of NPK fertilizer in the treatments. Similar results was observed for content of Fe, Mn, Zn, Cu and B in leaf of coconut. Soil pH value was positively correlated with leaf P content in coconut which explains that leaf P content is directly proportional to the soil pH value. Electrical conductivity (EC) of soil was also positively correlated with P, K and B concentration in coconut leaf which confirms that coconut plant grows well in soils contained with soluble salt. Correlation coefficient value between CEC and leaf nutrient contents explains that 2nd depth of soil is more important for mineral nutrition of coconut palm. Coefficient of correlation between nitrogen content in soils of upper two depths and leaf nutrient content suggested that nitrogen concentration in soil to a depth of 0-60 cm is most effective for coconut plant growth and development. Correlation coefficient values between soil P content and leaf nutrient content explains that with increasing levels of phosphatic fertilizer in soil increases other macro and micronutrient uptake to the crop plant. Negligible correlation between sulphur content in leaf and soil was found. Higher correlation coefficient value was found at lower soil depth between available sulphur content in soil and sulphur content in leaf of coconut. Very negligible coefficient of correlation was found between leaf nutrient concentration and Fe, Mn, Zn, Cu and B content in soil. This result suggests that inherent supplying capacity of micronutrient of experimental soil is not so influential for higher plant growth, but application of N, P and K fertilizers trigger the absorption capacity for micronutrient from soil. Under different NPK levels, the applied NPK does not have significant effect on leaf N, P, S, Zn content after five (5) years of experimentation while the effect was found to be significant for few elements like K, Fe, Mn, Cu, and B. An increasing trend was observed for leaf nutrient content with increasing levels of fertilizer application.

Keywords: Drip fertigation, Coconut leaf, Nutrient status

1. INTRODUCTION

The coconut palm (*Cocos nucifera* L.) globally cultivated in around 93 countries and in India, it is grown in 2.1 million ha (2015-16, 3rd estimates) with a production of 14 075 million nuts and an average productivity of 6 702 nuts/ha/year (CDB 2016). In fertigation method, nutrient use

efficiency could be as high as 90% compared to only 40–60% in conventional methods (Basavaraju et al., 2014). In fertigation method, the amount of nutrients lost through leaching can be as low as 10%, whereas it can be >50% in the traditional system (Solaimalai et al., 2005). Soil nutrient status can be improved by fertilization but maximum plant growth could only be achieved when the nutrient availability matches with water availability (Amer et al., 2009). Therefore, the development of water and fertilizer management technology that enhance efficient water use has become an important strategy to guarantee sustainable crop production. In order to sustain the quality and quantity of crop production system, maintaining and improving soil fertility is very important, and this can only be achieved by applying fertilizers either in inorganic or organic form (Efthimiadou et al. 2010). Adeniyani & Ojeniyi (2006) stated that the main purpose of fertilization in agriculture is to obtain a high yield and to enhance soil fertility. Adoption of drip fertigation method is an option for efficient use of water and nutrients through improvement in crop yield per unit volume of water and nutrients used (Patel and Rajput, 2011). Keeping this in view, the present investigation was carried out to determine the effect of different fertigation levels on plant nutrient contents of coconut especially in leaves with a goal to how fertigation affects nutrient contents in plants after five year of application.

2. METHODOLOGY

2.1 Experimental site, soil and weather

The present investigation entitled "Effect of drip fertigation with different fertilizer levels on nutrient status in coconut (*Cocos nucifera* L) leaf " was conducted during 2017-18 under the All India Co-ordinated Research Project initiated in 2009 at research farm of Bihar Agricultural University, Sabour, Bhagalpur. In this section, efforts have been made to present observations including nutritional status of coconut leaf after long term drip fertigation. Soil was silty clay loam type in texture. Coconut seedling was first planted in the experimental farm in 2009. Plant to plant distance is 25'x 25' both ways. Drip irrigation alongwith fertilizer application (Fertigation) was imposed on this experiment in 2012 with urea, diammonium phosphate, muriate of potash. The experimental area is situated in tropical to sub-tropical climate and is characterized by hot desiccating summer, cold winter and moderate annual rainfall with latitude and longitude of 25°14'11" N and 87°04'1.6" E respectively. Altitude of the area is 52.73 m above mean sea level. This area receives an average annual precipitation of 1407 mm (mean of 10 years). December and January are usually the coldest month where the mean temperature normally fall as low as 8.2°C and April and May are the hottest months having maximum average temperature of 36.6°C.

2.2 Treatments detail

T1 = Control (No fertilizer), T2 = 25% of the recommended dose of NPK fertilizers (RDF) through drip system, T3 = 50% of the RDF through drip system, T4 = 75% of the RDF through drip system, T5 = 100% of the RDF through drip system, T6 = 100% of the RDF through soil application.

2.3 Experimental design

The experiment was formulated in a Randomized Block Design (RBD) with four (4) replications. Each treatment plot occupies four coconut palms. Drip fertigation is provided during dry season from October to May every year with 8 equal split application of fertilizer. The amount of fertilizers that is scheduled to be applied through direct soil application is splitted into two equal halves and are applied once during April-May (pre monsoon season) and another during October-November (post monsoon season) every year.

2.4 Plant sample and analysis

Plant leaf samples were collected from experimental coconut palm. Every 6th/7th leaf from the top of each experimental palm was selected for sampling. Middle leaflets were taken from each selected leaf and then middle portion of each leaflet was considered for the study. The midrib of leaflets were separated, washed first in running tap water followed by dilute 0.01 N HCl and finally with double distilled water. The plant leaf materials were dried first in air and then in oven at 65°C to a constant weight. Then, samples were ground in a stainless steel grinder (Willey-mill) and stored in dessicator for further analysis.

2.5 Analysis for Total N, P, K, S, Fe, Cu, Mn, Zn, B in coconut leaf for nutrient status after long term fertigation

2.5.1 Total Nitrogen

Total nitrogen (N) was determined by using concentrated H_2SO_4 and digestion accelerator mixture (K_2SO_4 : CuSO_4 :: 10:1) as described by Jackson (1973) and the digest was steam distilled with concentrated 40% NaOH.

2.5.2 Total P

For determination of Total P, K, S plant samples were digested with di-acid mixture (HNO_3 : HClO_4 ::9:4) with HCl on hot plate as described by Blanchar *et al.*, (1965). The phosphorous in digest was determined by Vanado-molybdate solution with yellow colour appearance and reading was taken by spectrophotometer at 760 nm (Page *et al.*, 1982).

2.5.3 Total K

Total potassium in Plant sample digest (prepared as in total phosphorous) was determined by flame photometric method (Jackson, 1973).

2.5.4 Total S

Total sulphur content in plant digest (prepared as in total phosphorous) was determined turbidimetrically by using BaCl_2 crystal (retained in 30 to 60 mesh sieve) and gum acacia method of Chesnin and Yien (1951) using a spectrophotometer at 420 nm wavelength.

2.5.5 Total Micronutrients (Fe, Cu, Mn, Zn)

Micronutrients from plant sample digest (prepared as in total phosphorous) were estimated by the help of Atomic Absorption Spectrophotometer.

2.5.6 Total B

The boron concentration in ground leaf samples was determined following the standard method of dry ashing and colorimetric analysis by Azomethine-H (Gaines and Mitchell, 1979). Boron content in the filtrate was determined spectrophotometrically by Azomethine-H method as described by Berger and Truog (1939).

2.5.7 Statistical analysis

The mean value, critical difference, coefficient of variance of each parameter and the correlation coefficients between leaf nutrient contents and different soil chemical characteristics as well as available nutrients were calculated as per procedure referred in Gomez and Gomez (1983). Microsoft excel package (Office - 2003) and Statistical Package for the Social Science (SPSS) were used for the analysis.

3. RESULTS AND DISCUSSION

3.1 Effect of different levels of chemical fertilizer on nutrient content in coconut leaf

Laboratory analysis data of leaf samples of coconut under long term (5 year) fertigation treatments is presented in the table 2. Nitrogen content in coconut leaves under different fertigation treatments was not significantly different from each other. But its content in leaf was increasing gradually with increasing levels of fertilizers in the drip fertigation system. Highest content of nitrogen was found in T5 treatment (1.82 mg kg^{-1}) (Table 2) which was 19.0% more than that in control treatment (1.53 mg kg^{-1}). Increase (%) in nitrogen content of leaves under different treatments over control was in the order of T5> T4 (17.6%)> T3 (10.5%)> T6 (5.9%)> T2 (3.9%). Nitrogen content in the coconut leaf was found to be increasing with increasing levels of fertilizer in the experiment but this increase was not significantly different among treatments. Srinivas (1997) reported that the nutrient uptake (N, P and K) in leaf increased with the increase in nitrogen application through drip irrigation. Highest content of leaf N content was found in T5 treatment that might be due to the effect of highest quantity of nitrogenous fertilizer application *i.e.* 100% recommended dose in soil through drip irrigation. But plant leaves under T6 treatment resulted in comparatively very less nitrogen content than T5 treatment because of direct soil application of nitrogenous fertilizer which is very prone to volatilization loss immediately after application.

Phosphorus content in coconut leaves under different fertilizer treatments was also not significantly different from each other. Gradual increase in the content of phosphorus in leaf was observed with increasing levels of fertilizer in the treatments. Highest content of phosphorus was found (Table 2) in T6 (1.60 mg kg^{-1}) treatment (100% RDF through soil application) which was 55.3% increase over the control treatment (1.22 mg kg^{-1}). The order of percent increase in the content of phosphorus in the coconut leaf under different treatment over control was T6> T5 (37.9%)> T4 (35.9%) = T3 (35.0%)> T2 (18.4%). Effect of all the treatments on leaf phosphorus content of coconut was also not significantly different, but the highest content was found in T6 treatment that may be due to the effect of direct soil application of 100% RDF for phosphatic

fertilizer to the upper layer of soil. As phosphate is immobile in nature in soil and has very less chances of loss from soil, plant root absorb high quantity of phosphate which reflected in the leaf content under T6 treatment. But T5 treatment where 100% RDF of phosphatic fertilizer was applied through drip irrigation, resulted in little less content of P in leaf than T6 treatment but both treatments were not significantly different that may be due to immobile nature of phosphorus in soil.

Unlike nitrogen and phosphorus, potassium content in coconut leaf under different drip fertigation treatments was significantly different from each other. Leaf content (Table 2) of potassium was found highest in T5 treatment (1.42 mg kg^{-1}) which was 52.7% increase over control treatment (0.93 mg kg^{-1}). There was gradual increase in the leaf potassium content observed with increasing levels of drip fertigation treatments whereas T6 treatment (100% RDF through soil application) resulted much lower values than T5 (full dose of fertilizer application with drip irrigation). The percent increase in the content of potassium in leaf under various treatments followed the order of T5 > T4 (47.3%) > T3 (45.2%) > T6 (34.4.1%) > T2 (15.1%). Potassium content in coconut leaf in all the treatments was significantly different because potassium is highly soluble and highly mobile in nature in soil. With increasing levels of potassic fertilizer in the treatments increase potassium content in soil across the soil depths which reflected in the potassium content in the coconut leaf. It's content in leaf under T5 and T4 treatments were higher than T6 treatment that may be due to high downward movement of potassium ion in soil through drip irrigation water.

Sulphur content in coconut leaf under different fertigation treatments was not significantly different from each other. Among the all treatments, highest sulphur in leaf was recorded (Table 2) in T5 treatment (3.44 mg kg^{-1}) which was 18.2% increase over the control treatment (2.91 mg kg^{-1}). A gradual increase of the leaf sulphur was recorded with increasing level of fertigation treatments whereas T6 treatment (100% RDF through soil application) resulted in lesser content of sulphur than T5 treatment (100% RDF through drip fertigation). The percent increase in the content of sulphur in leaf under various treatments followed the order of T5 > T4 (17.2%) > T3 (14.8%) > T6 (14.4%) > T2 (2.7%). All the treatments for sulphur content in leaf of coconut were not significantly different but its content increases with increasing levels of NPK fertilizer in the treatments. Similar phenomenon also found for content of Fe, Mn, Zn, Cu and B in leaf of coconut. This evidence proves the application of higher amount of NPK fertilizers into the soil leads to the mining of inherent source of essential macro and micro nutrients from soil.

Among all micronutrients in coconut leaf, it was observed that a significant difference in iron content in leaf from each other was observed under different drip fertigation treatments. In T5 treatments, highest ($299.75 \text{ mg kg}^{-1}$) iron content was recorded (Table 2) in coconut leaf which was 95.3% increase over control ($153.50 \text{ mg kg}^{-1}$). Gradual increase of iron content in the leaf was observed with increasing levels of drip fertigation treatments but T6 treatment (100% RDF through soil application) showed lesser value than T5 treatments (100% RDF through drip fertigation). The order of percent increase of iron content in leaf followed the order of T5 > T4 (84.2%) > T3 (73.6%) > T2 (44.8%) > T6 (43.8%).

Similarly, for manganese content in leaf, significant difference was observed under different fertigation treatments. T5 treatment resulted highest (39.50 mg kg^{-1}) content (Table 2) of Mn in coconut leaf that was 305.1% higher than control (9.75 mg kg^{-1}). Mn content in coconut leaf was gradually increased with increasing levels chemical fertilizer through drip irrigation and T6 treatment showed a lesser Mn value with respect to T5 treatment (100 % RDF through drip fertigation). The percent increase of Mn content in coconut leaf was in the order of T5 > T4 (189.7%) > T6 (143.6%) > T3 (138.5%) > T2 (79.5%).

All the treatments under this study were statistically at par for the content of zinc coconut leaf. Highest content of Zn in leaf was found (Table 2) in T5 treatment (25.00 mg/kg) which was 63.9% increase over control (15.25 mg kg^{-1}). Zinc content in coconut leaf was gradually increasing with increasing levels of drip fertigation treatments whereas T6 treatment (100% RDF through soil application) resulted in lower Zn content with respect to T5 treatment (100 % RDF through drip irrigation). The order of percent increase of Zn content in coconut leaf was T5 > T4 (50.8%) > T3 (47.5%) > T6 (24.6%) > T2 (16.4%).

Copper content in coconut leaf under different fertilizer treatments were significantly different from each other. Drip irrigation with higher doses of fertilizers resulted (Table 2) similar values (6.25 to 6.50 mg kg^{-1}) for copper content in leaf which was 92.3 to 100% increase over control.

Boron contents in the leaf of coconut under different fertilizer treatments were significantly different from each other. There was highest value observed (Table 2) in treatment T5 (16.16 mg kg^{-1}) which was 154.1% increase over control (6.36 mg kg^{-1}). Boron content in coconut leaf was gradually increased with increasing fertilizer dose. The order of percent increase in the content of

boron in the coconut leaf under different treatment over control was T5 > T4 (109.3%) > T2 (84.4%) > T6 (73.1%) > T3 (67.5%).

Table 3 explains that Chemical properties of soil influence the nutrient absorption phenomenon by the plant. Soil pH directly influences the availability of phosphate ion in soil. Soil pH value was positively correlated with leaf P content in coconut which explains that leaf P content is directly proportional to the soil pH value. Electrical conductivity of soil was also positively correlated with P, K and B concentration in coconut leaf which confirms that coconut plant grows well in soils contained with soluble salt. Correlation coefficient value between CEC and leaf nutrient contents explains that 2nd depth of soil is more important for mineral nutrition of coconut palm. Results of correlation coefficient between organic carbon and leaf nutrient content put the evidence that organic carbon content in soil at different depth does not play so important role in mineral nutrition for higher perennial plant.

Coefficient of correlation between nitrogen content in soils of upper two depths and leaf nutrient content suggested that nitrogen concentration in soil to a depth of 0-60 cm is most effective for coconut plant growth and development and nitrogen content at lowest depth (60-90 cm) has no importance. It also explains that with increasing availability of nitrogen in upper 60cm soil increases the micronutrient uptake from soil by the plant.

Correlation coefficient values between soil P content and leaf nutrient content explains that with increasing levels of phosphatic fertilizer in soil increases other macro and micronutrient uptake to the crop plant. At a depth of 30-60 cm in the soil profile is highly effective source of P for uptake by coconut palm.

Coefficient of correlation values suggested that all three soil depths were equally responsible for potassium supply to the coconut leaf nutrition and micronutrients concentration in leaf increases with increasing levels of potassic fertilizer in the treatments.

Negligible correlation between sulphur content in leaf and soil was found that may be due to no application of S fertilizer from external source in the experiment. Sulphur is highly soluble and leachable, therefore comparatively higher correlation coefficient value found at lower soil depth between available sulphur content in soil and sulphur content in leaf of coconut.

Very negligible coefficient of correlation was found between leaf nutrient concentration and Fe, Mn, Zn, Cu and B content in soil. This result suggests that inherent supplying capacity of micronutrient of experimental soil is not so influential for higher plant growth, but application of N, P and K fertilizers trigger the absorption capacity for micronutrient from soil.

3.3 Relationship between plant leaf nutrient concentration and soil chemical properties

Co-efficient of correlation value between coconut leaf nutrient concentration and some soil chemical properties are presented in the table 3.

Soil pH value at three different depths was positively and significantly correlated with phosphorus content in leaf ($r = 0.46^*$, 0.60^{**} , 0.45^*) (Table 3). But pH at 2nd depth of soil was highly significant than other depth. Electrical conductivity of soil at three different depths was found be positive but non-significant correlation with available phosphorus ($r = 0.13$, 0.26 , 0.20) and potassium ($r = 0.09$, 0.27 , 0.37) content in coconut leaf. EC of 2nd depth of soil was positively and significantly correlated with B ($r = 0.42^*$) content in coconut leaf.

Positive correlation value was found between cation exchange capacity (CEC) and all the leaf nutrient content. But among three soil depths, CEC at 2nd depth showed higher values of coefficient of correlation with all the leaf nutrient concentration. Organic carbon (OC) content in soil at three different depths was not markedly correlated with any leaf nutrient concentration.

Coefficient of correlation values between nutrient concentration in coconut leaf and available nutrient content in soil is presented in the table 4 to compare the plant nutrition study under different levels of fertilizer through irrigation.

Nitrogen content in surface soil, D1 (0 – 30 cm) was positively correlated (Table 4) with leaf N ($r = 0.40$) and leaf P ($r = 0.37$) content but significantly correlated with leaf K ($r = 0.60^{**}$), leaf S ($r = 0.48^*$), leaf Fe ($r = 0.60^{**}$), leaf Mn ($r = 0.73^{**}$), leaf Zn ($r = 0.54$), leaf Cu ($r = 0.47^*$) and leaf B ($r = 0.56^{**}$) concentrations. Similar relation also found between 2nd depth (D2) of soil and leaf nutrient concentrations. But at 3rd depth of soil, this relation was negligible.

Phosphorus concentration at 0 – 30 cm depth (D1) of soil was positively correlated with leaf N ($r = 0.49^*$), leaf P ($r = 0.29$), leaf K ($r = 0.48^*$), leaf S ($r = 0.44^*$), leaf Fe ($r = 0.42^*$), leaf Mn ($r = 0.63^{**}$), leaf Zn ($r = 0.35$), leaf Cu ($r = 0.33$) and leaf B ($r = 0.47^*$) concentrations (Table 4). But P content at D2 *i.e.* 30-60 cm soil showed highest correlation coefficient value with leaf P ($r = 0.35$).

Potassium content in soils of all three depths was positively correlated with all the leaf nutrient parameters. But more significant correlation coefficient value found with leaf micronutrients content in coconut.

Sulphur content in soil across the soil depths was negligibly correlated with the leaf nutrients content. Very small positive correlation value found (Table 4) between leaf S content and available S content in soil at three different depth ($r = 0.05$, 0.14 , 0.20). Very negligible coefficient

of correlation values found between leaf nutrient element concentration and Fe, Mn, Zn, Cu and B content in soil across the soil depths.

Table 1. Details of the treatments

Treatments	Fertilizer application (g plant ⁻¹ year ⁻¹)		
	N	P ₂ O ₅	K ₂ O
No fertilizer	0	0	0
25% RDF NPK	250	112	300
50% RDF NPK	500	225	600
75% RDF NPK	750	300	900
100% RDF NPK	1000	450	1200

Table 2. Effect of long term (5 years) fertigation on macro and micronutrients content (mg kg⁻¹) in coconut leaf

Treatments	N	P	K	S	Fe	Mn	Zn	Cu	B
	(in %)				(in mg kg ⁻¹)				
T1	1.53	1.03	0.93	2.91	153.50	9.75	15.25	3.25	6.36
T2	1.59 (3.9)*	1.22 (18.4)	1.07 (15.1)	2.99 (2.7)	222.22 (44.8)	17.50 (79.5)	17.75 (16.4)	4.50 (38.5)	11.73 (84.4)
T3	1.69 (10.5)	1.39 (35.0)	1.35 (45.2)	3.34 (14.8)	266.50 (73.6)	23.25 (138.5)	22.50 (47.5)	6.50 (100.0)	10.65 (67.5)
T4	1.80 (17.6)	1.40 (35.9)	1.37 (47.3)	3.41 (17.2)	282.75 (84.2)	28.25 (189.7)	23.00 (50.8)	6.25 (92.3)	13.31 (109.3)
T5	1.82 (19.0)	1.42 (37.9)	1.42 (52.7)	3.44 (18.2)	299.75 (95.3)	39.50 (305.1)	25.00 (63.9)	6.25 (92.3)	16.16 (154.1)
T6	1.62 (5.9)	1.60 (55.3)	1.25 (34.4)	3.33 (14.4)	220.75 (43.8)	23.75 (143.6)	19.00 (24.6)	3.75 (15.4)	11.01 (73.1)
Mean	1.68	1.34	1.23	3.24	240.91	23.67	20.42	5.08	11.54
CD (0.05)	NS	NS	0.31	NS	91.85	7.58	NS	2.34	5.18
CV (%)	15.00	11.84	6.55	14.92	15.30	2.12	2.33	3.05	2.98

* Figure in the parenthesis represents percent (%) increase over control treatment
Unit of N, P, K, S are in % whereas unit of micronutrients are in mg kg⁻¹

Table 3. Co-efficient of correlation value between chemical properties of soil and nutrient concentrations in plant

Parameters	Soil depth	Leaf N	Leaf P	Leaf K	Leaf S	Leaf Fe	Leaf Mn	Leaf Zn	Leaf Cu	Leaf B
Ph	D1	-0.05	0.46*	0.30	0.10	-0.02	0.10	0.18	-0.05	0.11
	D2	-0.07	0.60**	0.36	0.24	0.04	0.20	0.20	0.15	0.20
	D3	-0.08	0.45*	0.27	0.15	0.04	0.35	0.25	0.19	0.29
EC	D1	-0.03	0.13	0.09	-0.09	-0.15	-0.09	-0.33	-0.21	-0.01
	D2	-0.14	0.26	0.27	0.25	-0.04	0.25	0.23	0.26	0.42*
	D3	0.01	0.20	0.37	0.29	0.31	0.33	0.41*	0.39	0.44*
CEC	D1	0.08	0.33	0.33	0.05	0.14	0.40	0.26	0.07	0.13
	D2	0.34	0.17	0.45*	0.23	0.50*	0.49*	0.37	0.37	0.30
	D3	0.01	-0.09	0.01	-0.05	-0.09	-0.18	0.06	0.07	-0.10
OC	D1	0.17	0.24	0.20	0.27	-0.06	0.25	-0.01	0.29	0.15
	D2	-0.08	0.28	0.12	-0.04	-0.10	0.16	-0.16	-0.11	-0.14
	D3	0.03	-0.06	-0.06	0.02	-0.15	0.16	-0.10	-0.07	0.01

D1 : 0 – 30 cm soil depth, D2 : 30-60 cm soil depth, D3 : 60-90 cm soil depth

* and ** : refer to level of significance at 0.05 and 0.01 probability level respectively

Table 4. Co-efficient of correlation value between available nutrient content in soil and nutrient concentrations in plant

Parameters	Soil Depth	Leaf N	Leaf P	Leaf K	Leaf S	Leaf Fe	Leaf Mn	Leaf Zn	Leaf Cu	Leaf B
Available N	D1	0.40	0.37	0.60**	0.48*	0.60*	0.73*	0.54*	0.47*	0.56*
	D2	0.40	0.14	0.58**	0.31	0.59*	0.76*	0.39	0.48*	0.49*
	D3	-0.03	-0.11	0.15	0.14	0.12	0.17	-0.03	0.01	0.23
Available P	D1	0.49*	0.29	0.48*	0.44*	0.42*	0.63*	0.35	0.33	0.47*
	D2	0.01	0.35	0.29	0.34	0.07	0.30	0.24	0.21	0.27
	D3	0.09	0.25	0.63**	0.09	0.30	0.44*	0.35	0.23	0.26
Available K	D1	0.17	0.09	0.35	0.26	0.42*	0.35	0.50*	0.44*	0.16
	D2	0.12	0.12	0.17	0.14	0.53*	0.56*	0.55*	0.36	0.29
	D3	0.42*	0.06	0.31	0.39	0.68*	0.62*	0.57*	0.63*	0.55*
Available S	D1	0.06	0.19	-0.10	0.05	-0.15	-0.06	-0.10	-0.07	0.01
	D2	0.05	-0.08	-0.22	0.14	-0.13	-0.26	0.10	0.28	-0.03
	D3	-0.03	-0.17	-0.07	0.20	-0.01	-0.21	-0.08	-0.05	0.03
Available Fe	D1	0.14	-0.04	0.13	0.05	0.19	0.07	0.23	0.38	0.03
	D2	-0.23	-	-0.40	-0.10	-0.23	-	-	-0.01	-0.22
	D3	-0.12	-0.24	-0.30	-0.23	-0.17	-0.05	0.06	0.33	-0.12
Available Mn	D1	0.05	0.21	0.10	0.32	0.07	0.14	0.34	0.04	0.26
	D2	-0.02	0.15	0.14	-0.01	0.05	-0.07	-0.32	-0.38	-0.30
	D3	0.08	-0.07	-0.37	-0.08	-	-0.38	0.04	0.01	-0.26
Available Zn	D1	0.24	0.50*	0.21	0.22	0.17	0.38	0.01	-0.05	0.47*
	D2	-0.05	-	-0.19	-0.22	-0.10	-0.11	-0.09	-0.08	-0.09
	D3	0.39	0.37	0.60**	0.37	0.60*	0.67*	0.58*	0.56*	0.60*
Available Cu	D1	-0.02	0.11	-0.13	0.01	-0.07	0.01	0.04	-0.01	0.06
	D2	0.01	-0.10	-0.25	0.04	-0.21	-0.10	0.12	0.07	0.05
	D3	-0.23	-0.26	-0.15	-0.10	-0.21	-0.19	-0.05	-0.05	-0.15
Available B	D1	-0.18	0.34	0.03	0.06	0.08	0.15	-0.12	-0.21	0.12
	D2	0.07	-0.35	-0.14	-0.12	-0.02	-0.04	-0.29	-0.02	0.07
	D3	0.08	-	-0.17	-0.06	-0.09	0.06	-0.10	0.14	0.03

D1 : 0 – 30 cm soil depth, D2 : 30-60 cm soil depth, D3 : 60-90 cm soil depth

* and ** : refer to level of significance at 0.05 and 0.01 probability level respectively

4. CONCLUSION

Leaf N, P and S content under different fertigation treatments were not significantly different from each other. All the treatments for leaf K content were significantly different. But the content of these elements in leaf were increasing gradually with increasing levels of fertilizers in the drip fertigation treatments. Iron, manganese, copper and boron content in coconut leaf under different treatments were significantly different. But all the treatments for

Zn content were at par. The content of these micronutrients in leaf were found to increase with increasing levels of fertilizer in the treatments. CEC was positively correlated with all the leaf nutrients. Organic carbon did not show remarkable relation with plant nutrient parameters. Soil K content of all three depths was positively correlated with all the leaf nutrient elements, but more significant correlation coefficient value found with leaf micronutrients. S, Fe, Mn, Zn, Cu and B content in soil across the soil depths was negligibly correlated with the leaf nutrients elements content.

Under different NPK levels, the applied NPK does not have significant effect on leaf N, P, S, Zn content after five (5) years of experimentation while the effect was found to be significant for few elements like K, Fe, Mn, Cu, and B. An increasing trend was observed for leaf nutrient content with increasing levels of fertilizer application. The conclusions of this study were based only on five years of drip fertigation experimentation data and the results may have some boundaries and restrictions and so further research is required in future.

REFERENCES

1. Adeniyi O, Ojeniyi S. Effect of poultry manure, NPK 15-15-15 and combination of their reduced levels on maize growth and soil chemical properties. *Nigerian J. Soil Science*.2006; 15(1):34-41.
2. Amer KH, Midan SA, Hatfield JL. Effect of deficit irrigation and fertilization on cucumber. *Agronomy Journal*.2009; 101(6):1556-1564.
3. Basavaraju TB, Bhagya HP, Prashanth M, Arulraj S, Maheswarappa HP. Effect of fertigation on the productivity of coconut. *Journal of Plantation Crops*. 2014;42(2): 198–204.
4. Berger KC, Truog E. Boron determination in soils and plants. *Industrial & Engineering Chemistry Analytical Edition*.1939; 11(10): 540-545.
5. Blanchar RW, Rehm F, Caldwell AF. Sulfur in plant materials by digestion with nitric and perchloric acid. *Soil Science Society of America Proceedings*.1965; 29:71-72.
6. CDB. Coconut Statistics 2015-16. Coconut Development Board, India <http://www.coconutboard.gov.in/presentation/statistics>. 2016.
7. Chesnin L, Yien CH. Turbidimetric Determination of Available Sulphur. *Proceedings of Soil Science Society of America*.1951; 15:149-151.
8. Efthimiadou A, Bilslis D, Karkanis A, Froud Williams B. Combined organic/ inorganic fertilization enhances soil quality and increased yield, photosynthesis and sustainability of sweet maize crop. *Australian Journal of Crop Science*. 2010; 4(9):722-729.
9. Gaines TP, Mitchell GA. Chemical methods for soil and plant analysis. *Chemical methods for soil and plant analysis (1)*.1979.
10. Jackson ML. *Soil Chemical Analysis*. Prentice Hall India Pvt. Ltd., New Delhi. 1973;498.
11. Page AL, Miller RH, Keeney DR (eds). *Methods of Soil Analysis: Part 2, Chemical and Microbiological Properties*. Agronomy Series No 9, American Society of Agronomy, Madison, WI.1982.
12. Patel N, Rajput TBS. Simulation and modeling of water movement in potato (*Solanum tuberosum*).*The Ind. J Agrl. Sci*. 2011;81, 25-32.
13. Solaimalai, A., M. Baskar, A. Sadasakthi, and K. Subburamu. Fertigation in high value crops- A review. *Agric. Rev*.2005; 26(1):1–13.
14. Srinivas K. Growth, yield and quality of banana in relation to N fertigation. *Tropical Agriculture*.1997; 74:260.