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Depth wise vertical distribution of nutrients after long term drip fertigation in coconut in indo-gangetic plain of South Bihar Alluvial Zone (a)

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Abstract
A field experiment was conducted in All India Coordinated Research Project on Coconut (AICRP-palms, Sabour) under drip fertigation system. In order to generate information under long term (5 years) drip fertigation, with the following six treatment combinations *viz.* (i) control (T1), (ii) 25% of the recommended dose of NPK fertilizers (RDF) through drip system (T2), (iii) 50% RDF through drip, (iv) 75% RDF through drip, (v) 100% RDF through drip, and (vi) 100% RDF through soil application (T6) a dissertation work was taken in the Department of Soil Science and Agricultural Chemistry, Bihar Agricultural University, Sabour, Bihar. The experiment was carried out in randomized block design (RBD) with six treatments and replicated four. The soil of experimental plot was silty clay loam type in texture under low available in N, P and K with pH 7.3(check the initial value). Among all parameters like Available and total N, P and K were recorded higher with the application of treatment T5 - 100% of the RDF through drip system which was significantly superior over other treatment but was statistically at par with T4 at all depths of soil. The maximum P value was observed in T6 treatments which was at par with T5 treatment in surface soil (0-30 cm). Available micro nutrients content in soil recorded non-significant difference among the all treatments under drip fertigation study.

Keywords: Soil sample, fertigation, nutrients

Introduction

Coconut (*Cocos nucifera* L.) is grown in different farming systems and soils in almost all countries of South Asia, and most notably in the coastal areas (Coconut Development Board, 2015). It is an important commercial plantation crop in India and plays an important role in the Indian economy by contributing around $105 million per year to the national GDP (Jayakumar *et al*., 2015). In India, it was grown in approximately 2.08 million ha with production of 2.39 million nuts in 2016–2017. According to all India final estimates of area and production of coconut 2016-17, in Bihar, coconut covers 14900 ha with production and productivity 141.09 million nuts & 9469 nuts/ha respectively. Among the various irrigation systems, drip irrigation is gaining importance in South Asia as it can maintain soil moisture near field capacity and appropriate air balance in the root zone of coconut throughout the dry season (Carr, 2011) [4]. In other words, drip system can be used to apply water and water-soluble fertilizers or chemicals in precise amount directly to the root zone (e.g., fertigation) as and when required to match the plant needs (Jayakumar *et al.,* 2014, 2015) [9]. In fertigation method, nutrient use efficiency could be as high as 90% compared to only 40–60% in conventional methods (Basavaraju *et al.,* 2014) [1]. 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) [24]. The advantage of fertigation method over conventional method of fertilizer application was also emphasized by several other works (Mmolawa and Or, 2000; Mohammad, 2004a, 2004b; Shigure *et al*., 1999) [15, 22]. However, there is very meager information on fertigation effects on productivity, and soil and plant nutrition of coconut in the Eastern IGP of South Asia, or largely in India. However, in indogangetic plain of South Bihar Alluvial Zone (a) there is very less information available regarding soil nutrient status depth wise, leaf nutrient status of coconut after long term drip fertigation. Keeping in perspective, this investigation was performed to determine the effect of different fertigation level on soil nutrient status depth wise. So that, overall productivity, losses, fertilizer requirement can be calculated and these work should be used in further research.

Materials and methods

Description of experimental site, weather and year

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 ^{0}14’11˝ N and 87 ^{0}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 ^{0}C and April and May are the hottest months having maximum average temperature of 36.6 ^{0}C.

The experiment was conducted in All India Coordinated Research Project on Coconut (AICRP- palms, Sabour) variety Shakhi Gopal Tall under drip fertigation system. Coconut needs irrigation on a regular basis which helps in improving the bearing capacity and quality of the nuts. Drip fertigation allows continuous irrigation and fertilizer injection into the root zone. Soil physicochemical properties are important aspects of soil quality that can change with long-term drip irrigation. In order to generate information under long term (5 years) drip fertigation, a dissertation work was taken in the Department of Soil Science and Agricultural Chemistry, Bihar Agricultural University, Sabour to study the “Effect of drip fertigation on soil fertility and plant nutrition in coconut” with the following six treatment combinations *viz.* (i) control (T1), (ii) 25% of the recommended dose of NPK fertilizers (RDF) through drip system (T2), (iii) 50% RDF through drip, (iv) 75% RDF through drip, (v) 100% RDF through drip, and (vi) 100% RDF through soil application (T6).

Soil was silty clay loam type in texture. Coconut seedling was planted during 2009. Plant to plant distance is 25’x 25’ both ways. Drip irrigation along with fertilizer application (Fertigation) was imposed on this experiment in 2012 with urea, di-ammonium phosphate, muriate of potash. Details of treatments are given as follows:

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

The experiment was formulated in a Randomized Block Design (RBD) with four (4) replications. Each treatment plot occupies four coconut palms.

Fertigation schedule and application:

Drip fertigation was done during dry season from October to May every year with 8 equal split application of fertilizer. The amount of fertilizers scheduled to be applied through direct soil application is split into two equal halves and was applied during April-May (pre monsoon season) and October-November (post monsoon season) every year.

Fertilizer application

Treatments	Fertilizer application (g plant^{-1} year^{-1})		
	N	P_2O_5	K_2O
No fertilizer	0	0	0
25% RDF NPK	250	112	300
50% RDF NPK	500	225	600
75% RDF NPK	750	337	900
100% RDF NPK	1000	450	1200

Soil sample collection and processing

Soil samples were collected at 1.0 m distance from the base of the coconut trunk during September-October just before. Sub samples at 0-30, 30-60 and 60-90 cm depth were collected with the help of Dutch auger. These sub samples were thoroughly mixed to prepare representative samples, air dried, grounded on a wooden plank with a wooden roller and passed through a 2 mm sieve and stored in the polythene packet for study. Sampling was drawn at post monsoon season just before the starting of fertilizer application and drip irrigation system. The soil sample thus obtained was subjected to various physical and chemical analyses under study.

Soil analysis procedures

Processed soil was analyzed for different physicochemical parameter

Methods

Here Coconut seedling was planted during 2009 with Plant to plant distance 25’x 25’ both ways. Drip irrigation along with fertilizer application (Fertigation) was imposed in 2012 in a Randomized Block Design (RBD) with four (4) replications the treatment details are listed below: T1 = Control, 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. Each treatment plot occupies four coconut palms. Drip fertigation was done during dry season from October to May every year with 8 equal split application of fertilizer. The amount of fertilizers scheduled to be applied through direct soil application is split into two equal halves and was applied during April-May (pre monsoon season) and October-November (post monsoon season) every year. Soil samples were collected at 1.0 m distance from the base of the coconut trunk during post monsoon season just before the starting of fertilizer application and drip irrigation system, with the help of Dutch auger at 0-30cm, 30-60cm and 60-90cm (three depth). Collected soil sample were kept in polythene bag and further processed for analysis and also stored in refrigerator for study of biological parameters. The bulk density (BD) of experimental area was determined by core method gravimetrically after drying soil sample at 105 ^{0}C for 24 hour in oven up to a constant weight. The particle density was determined by pycnometer method. Maximum water holding capacity was determined by using Keen Raczkowaski box method (Keen and Raczkowaski, 1921) [11] pH and EC were measured by the method described by Jackson (1973) [7]. Cation exchange capacity was determined by neutral normal ammonium acetate (1*N* NH4OAc) with the help of the method of Schollenberger as described in Black (1965). Organic carbon was determined by wet digestion method of Walkley and Black (1934) [26] as described in Black (1965). Available nitrogen was estimated by alkaline permanganate oxidation method as described by Subbaiah and Asija (1956). Available phosphorus content was estimated by Olsen’s method (Olsen *et al.*, 1954) [19]. Available potassium and in soil were determined by neutral ammonium acetate (1*N*) extract using flame photometer (Jackson, 1973) [7]. Extraction of available sulphur was done by using 0.15% $CaCl_2$ as per the method of Williams and Steinbergs (1959) [27] and the extracted sulphur was estimated by turbidimetrically method of Chesnin and Yien (1951) [5] using a spectrophotometer at 420 nm wavelength. Available Fe, Cu, Zn, Mn were estimated by Lindsay and Norvell (1978) [13] method with the help of atomic absorption spectrophotometer. Available boron content was estimated by reflux method using 0.02 M $CaCl_2$ solution with using Azomethine-H as colouring agent as described by John *et al.* (1975) [10]. Total nitrogen present in soil was determined by standard method (Piper, 1966) [21]. Total phosphorous of soil was determined by di-acid digestion and phosphorus in the digest was estimated by the vanadomolybdate yellow colour method (Page *et al.,* 1982) [20]. Total potassium and sodium were determined by using known volume of digest (prepared as in total phosphorus) and estimated by flame photometer (Page *et al.,* 1982) [20]. Total sulphur in the digest was estimated by using $BaCl_2$ crystal following the method of Chesnin and Yien (1951) [5]. Total micronutrient (Fe, Cu, Mn, Zn**)** in soil sample were determined by known volume of digest (prepared as in total phosphorous) by Lindsay and Norvell (1978) [13] method. The total B content of soil filtrate was determined spectrophotometrically by using Azomethine-H method colouring agent as described by John *et al.* (1975) [10] and dehydrogenase activity in soil was determined by spectrophotometric method as described by Klein e*t al.,* (1971) [12].

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.

Results and discussion

Long term (5 years) effect of drip fertigation on soil fertility status Vertical distribution of applied nutrients as influenced by long term (5 years) drip fertigation

The data on the vertical distribution of soil applied nutrients through drip fertigation and soil application along with control treatment are presented below.

Vertical distribution of N, P, K and S in soil Nitrogen

Available form of nitrogen or mineralizable nitrogen content in soil after five years of experiment across three different soil depths under drip fertigation is presented in the table 1. Highest content of available nitrogen was observed in T5 treatment (103.29 mg kg^{-1}) which was at par with T4 treatment (102.06 mg kg^{-1}) in surface soil (0-30 cm). Similar observation was found in second depth (30-60 cm) but T5 and T4 treatments were significantly different. Available nitrogen content was also significantly different across the soil depth. T5 treatment resulted in highest value for available nitrogen at each depth of soil and T4 treatment also resulted in second highest values at each depth of soil. But in T6 treatment, where fertilizers were applied through direct soil application, available nitrogen content was significantly lower than the T4 and T5 across all the soil depths. Application of nitrogenous fertilizer in soil through drip irrigation reduces the chances of volatile loss of nitrogen and increases the downward movement of nitrate in the soil profile which may increases its content in soil across the soil depths with increasing levels of fertilizer in the treatments. Shirgure *et al*. (2001) [23] also recorded a decline in available nitrogen under basin method of irrigation as compared to the drip fertigation.

Highest content of total nitrogen was found (Table 2) in treatments receiving higher doses of chemical fertilizer. Its content in 1st and 2nd soil depths was highest in T5 treatment (596.33 and 353.37 mg kg^{-1}) where fertilizer was applied through drip fertigation but in comparison, T6 treatment where fertilizer applied through soil application resulted significantly lower value (350.96, 340.97 mg kg^{-1}).

Phosphorus

The maximum value was observed in T6 (32.97 mg kg^{-1}) treatments which was at par with T5 treatment (30.81 mg kg^{-1}) in surface soil (0-30 cm). But a different trend was found in other depths (30-60 and 60-90 cm) where the highest value was observed in T5 treatments in both depths. Resulted data for available P also showed a significantly different value across the depths in each treatment. Highest value of available P was observed in lower depth soil depth in T5 (15.26, 10.45 mg kg^{-1}) treatment followed by T4 (11.33, 9.49 mg kg^{-1}) treatment and other treatments which was on par. Basavaraju *et al.* (2014) [1] reported for soil NPK status after 4 years of fertigation in coconut which was significantly higher with the application of 100 per cent NPK through drip irrigation as compared to other treatments and was at par with 75 per cent NPK through drip irrigation. Madake (2009) [14] studied the nutrient mobility, availability in soil and reported that the P moved upto 15 cm horizontally and upto 30 cm vertically in a drip fertigation study.

Total phosphorous in surface soil (Table 2) varied from 364.16 to 476.03 mg kg^{-1} soil. All the treatments also were significantly different from each other for total P content. In surface soil T4, T5 and T6 were statistically at par. But in 2nd depth T4 and T5 its content was significantly higher than the T6. There was increasing levels of total P content in soil with increasing levels of chemical fertilizer found under drip fertigation treatments.

Potassium

The highest value was recorded in T6 treatments (73.29 mg kg^{-1}) in surface soil (0-30 cm) but at 30-60 and 60-90 cm depth, it was highest (85.61, 80.73 mg kg^{-1} respectively) in T5 treatment. Resulted value in T6 treatment was at par with T5 and T4 treatments in upper soil depths. It also showed significantly different values across the soil depths in each treatment. Its content was increasing in surface soil with increasing levels of chemical fertilizer in all the treatments but T6 treatment followed lesser value to the lower soil depths. Vertical distribution of potassium along the soil depth showed higher values at the lower depth in drip fertigation treatments that might be due to continuous leaching of highly soluble potassium by the drip irrigation water through the soil profile. Better movement of K down the soil depth under drip irrigation has also been observed by Guennelon and Cabibel (1981) [6]. Carneiro *et al.* (2017) [3] reported for the layer of 20-40 cm of soil in a different study that the estimated increment of exchangeable K was 48.67 per cent of the maximum dose in relation to the minimum dose of K_2O applied through fertigation.

The maximum value was observed in T5 treatment which was at par with T4 treatments in all depths of soil. Resulted data (Table 2) for total K also showed a significantly different value across the soil depths in each treatment. However, in T6 treatments where 100% RDF was applied through soil application, total potassium content was lesser in comparison with T5 treatments.

Sulphur

Maximum content of available sulphur was found in T1 treatment (13.40 mg/kg) in surface soil (0-30 cm) but in second (30-60 cm) and third (60-90 cm) soil depth the highest value was recorded in T2 treatment (11.63 mg kg^{-1} and 8.79 mg kg^{-1}). Available sulphur content in soil decreases in the treatments with increasing levels of chemical fertilizer application but all the treatments were not significantly different. There was no option for application of sulphur containing fertilizer in this experiment. This common phenomenon found for sulphur content in soil across the treatments along the depths.

Total sulphur content in soil under different treatments (Table 2) ranged between 426.45 mg kg^{-1} in T6 treatment and 472.56 mg kg^{-1} in T1 treatment in surface soil and all the treatments were not significantly different from each other. A non-significantly decreasing order of total S content in soil was found with increasing levels chemical fertilizer applied treatments in this study. Across the three soil depths under different treatments, its content gradually decreased which were statistically and significantly different from each other.

Vertical distribution of micronutrients in soil Iron (Fe)

Highest content of available iron was found in T5 treatment (25.13 mg kg^{-1}) in surface soil (0-30 cm) and in 2nd and 3rd soil depths (*i.e.* 30-60 and 60-90 cm) it was resulted in T1 treatment. In surface soil all the treatments were statistically at par except T6. Its content in 2nd depth was decreasing with increasing levels of chemical fertilizers in all the treatments.

Total Fe content in soil under different treatments was significantly different from each other. Its content in soil was also significantly different across the soil depths. Its content in surface soil varied from 2449.58 to 2669.52 mg kg^{-1} soil (Table 4) across the treatments.

Manganese (Mn)

Highest content of available Mn was found in T5 treatment (14.85 mg kg^{-1}) in surface soil (0-30 cm) and in subsurface soil (30-60 and 60-90 cm) it was highest in T1 treatment (13.45, 11.04 mg kg^{-1}). Fertigation treatments with higher doses of fertilizer resulted less content of available Mn than the other treatments in 2nd depth of soil. Its content across the soil depth decreased significantly in all the treatments.

Resulted data for total Mn (Table 4) was also significantly different across the soil depth. Its content in surface soil varied from 266.17 to 369.03 mg kg^{-1} soil among the treatments. A decreasing order of total Mn content in soil was found with increasing levels of chemical fertilizer applied treatments in the lower soil depths.

Zinc (Zn)

All the treatments under this study were significantly different from each other for available Zn content in soil. Similar values of Zn (0.54 mg kg^{-1}) were resulted in all the treatments in surface soil (0-30cm) except T1 (0.53 mg kg^{-1}) which are presented in table 3. Similar types of results also observed in 2nd depth of soil also. Its content decreased significantly across the soil depth.

But total zinc content in soil among all the treatments under drip fertigation was not significantly different from each other. Although, it's content across the soil depths under the various treatments was significantly different from each other. Its content in surface soil (Table 4) varied from 43.06 to 46.56 mg kg^{-1} soil. A comparatively decreasing order of total Zn content in soil was found with increasing levels of chemical fertilizer applied treatments in the lower soil depths.

Copper (Cu)

Available form of Cu in soil under different drip fertigation treatments was statistically at par but significantly different across the three soil depths (Table 3). Surface soil contained highest amount of available Cu in every treatment, varied from 1.68 to 1.75 mg kg^{-1} soil. Its content was decreasing across the soil depth under study.

Total copper content in all soils under different treatments were significantly different from each other and also significantly different across the soil depths. Its content in surface soil (Table 4) varied from 11.06 to 17.63 mg kg^{-1} soil. A comparatively decreasing order of total Cu content in soil was found with increasing levels of chemical fertilizer applied treatments in the lower soil depths.

Boron (B)

Its content varied from 0.48 to 0.51 mg kg^{-1} soil in surface layer and significantly decreased its content across the soil depth in every treatment. Comparatively lower values of available B were obtained in the treatments receiving higher doses of chemical fertilizer across all the soil depths. Total boron content in all soils under different treatments and across the soil depth was significantly different from each other.

Its content in surface soil varied from 121.26 to 202.72 mg kg^{-1} soil (Table 4). A comparatively decreasing order of total B content in soil was found with increasing levels of chemical fertilizer applied treatments in the lower soil depths.

As there was no option for application of any micronutrient fertilizer from external sources in the study, requirement of micronutrients by plants were met up from inherent soils reserves. If plant gets merely primary nutrient elements from soil as well as externally applied fertilizer source at different levels of recommended dose, assimilate high amount of these elements along with other nutrient including micronutrient. Therefore, treatments supplied with different levels of recommended dose of NPK fertilizers resulted less quantity of Fe, Mn, Zn, Cu and B in the soil as compare to control treatment. Similar phenomenon also found in every soil depth of all treatments for Fe, Mn, Zn, Cu and B content. These results suggest that application of only N, P and K fertilizer to the soil leads to the mining of other nutrients from soil which ultimately disturbs the concept of soil sustainability.

Table 1: Effect of long term (5 years) fertigation on available N, P, K, S content in soil

Treatments	Available N				Available P				Available K				Available S			
	D1	D2	D3	Mean	D1	D2	D3	Mean	D1	D2	D3	Mean	D1	D2	D3	Mean
T1	52.75	44.51	44.38	47.21	11.82	7.93	5.44	8.40	40.88	60.24	47.46	49.53	13.40	10.73	8.44	10.86
T2	66.27	44.61	39.59	50.15	15.29	8.23	7.50	10.34	55.72	67.12	62.61	61.81	12.77	11.63	8.79	11.06
T3	79.08	49.66	39.08	55.94	17.13	9.29	9.15	11.86	61.62	76.86	67.44	68.64	12.87	10.39	7.83	10.36
T4	102.06	62.89	44.48	69.81	27.39	11.33	9.49	16.07	67.32	83.50	78.93	76.58	11.73	10.84	7.65	10.07
T5	103.29	77.53	44.54	75.12	30.81	15.26	10.45	18.84	68.97	85.61	80.73	78.44	11.91	10.04	7.86	9.94
T6	87.13	50.21	37.48	58.27	32.97	9.98	6.83	16.59	73.29	80.84	57.99	70.71	11.56	9.84	6.94	9.45
Mean	81.76	54.90	41.59		22.57	10.34	8.14		61.30	75.69	65.86		12.37	10.58	7.92	
			CD (P = 0.05)													

T	11.31		4.24		20.76		NS	
D	8.0		3.00		14.68		1.06	
T x D	19.59		7.34		NS		NS	
CV (%)	11.61		3.78		8.73		7.85	

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

Table 2: Effect of long term (5 years) fertigation on total N, P, K and S content (mg kg^{-1}) in soil

Treatments	Total N				Total P				Total K				Total S			
	D1	D2	D3	Mean	D1	D2	D3	Mean	D1	D2	D3	Mean	D1	D2	D3	Mean
T1	252.90	229.45	294.45	258.93	364.16	257.51	233.41	285.03	3208.75	3788.75	4189.75	3729.08	472.56	464.43	365.81	434.27
T2	412.21	314.67	247.27	324.72	375.16	272.99	254.65	300.93	3263.75	3977.50	4313.75	3851.67	466.09	451.75	277.83	398.56
T3	422.81	323.35	294.05	346.74	415.83	297.64	268.84	327.44	3320.00	4928.75	6461.25	4903.33	459.03	452.81	327.65	413.16
T4	499.27	339.70	323.68	387.55	455.50	305.55	283.81	348.29	3345.00	5192.50	6927.50	5155.00	452.08	444.47	346.55	414.37
T5	596.33	353.37	358.46	436.05	476.03	314.86	296.54	362.48	3791.25	5236.25	7031.25	5352.92	461.28	459.04	326.50	415.61
T6	350.96	340.97	372.96	354.96	456.67	262.68	244.49	321.28	3394.38	4938.13	6720.63	5017.71	426.45	448.16	314.54	396.38
Mean	422.41	316.92	315.15		423.89	285.21	263.62		3387.19	4676.98	5940.61		456.25	453.44	326.48	
			CD (P = 0.05)													
T	0.01				24.60				400.72				NS			
D	0.01				17.39				283.35				37.68			
T x D	0.01				NS				694.07				NS			
CV%	12.75				9.26				5.24				15.78			

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

Table 3: Effect of long term (5 years) fertigation on available micronutrient content (mg kg^{-1}) in soil

	Available Fe				Available Mn				Available Zn				Available Cu				Available B			
	D1	D2	D3	Mean	D1	D2	D3	Mean	D1	D2	D3	Mean	D1	D2	D3	Mean	D1	D2	D3	Mean
T1	24.26	19.48	12.90	18.88	14.58	13.45	11.04	13.02	0.53	0.44	0.14	0.37	1.74	0.54	0.34	0.87	0.49	0.23	0.15	0.29
T2	24.16	18.30	12.34	18.27	13.08	12.46	10.33	11.96	0.54	0.40	0.24	0.39	1.70	0.51	0.30	0.84	0.49	0.21	0.16	0.29
T3	24.60	17.73	12.17	18.17	13.95	13.17	10.19	12.44	0.54	0.40	0.24	0.39	1.68	0.53	0.30	0.84	0.50	0.21	0.15	0.29
T4	24.89	16.43	11.73	17.68	14.82	13.08	10.02	12.64	0.54	0.41	0.26	0.40	1.72	0.52	0.34	0.86	0.48	0.22	0.14	0.28
T5	25.13	14.77	12.11	17.34	14.85	12.83	10.37	12.68	0.54	0.42	0.27	0.41	1.72	0.53	0.31	0.85	0.48	0.21	0.14	0.28
T6	22.10	14.38	10.52	15.67	14.68	13.21	10.02	12.64	0.54	0.38	0.23	0.38	1.75	0.54	0.32	0.87	0.51	0.17	0.11	0.26
Mean	24.19	16.85	11.96		14.33	13.03	10.33		0.54	0.41	0.23		1.72	0.53	0.32		0.49	0.21	0.14	
				CD (P = 0.05)																
T	1.47				0.56				0.01				NS				NS			
D	1.04				0.39				0.01				0.02				0.01			
T x D	NS				NS				0.02				NS				NS			
CV(%)	10.12				5.40				3.34				4.17				8.73			

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

Table 4: Effect of long term (5 years) fertigation on total micronutrient content (mg kg^{-1}) in soil

Treatments	Total Fe				Total Mn				Total Zn				Total Cu				Total B			
	D1	D2	D3	Mean	D1	D2	D3	Mean	D1	D2	D3	Mean	D1	D2	D3	Mean	D1	D2	D3	Mean
T1	2449.58	2608.43	2627.73	2561.19	266.17	630.81	497.22	464.73	45.00	49.75	45.88	46.88	12.19	16.31	20.19	16.23	121.26	179.19	201.72	167.39
T2	2568.18	2579.70	2660.41	2602.76	369.03	483.14	652.64	501.60	46.25	48.38	43.50	46.04	13.88	14.88	27.25	18.67	134.84	166.51	159.21	153.52
T3	2610.99	2665.84	2612.78	2629.87	341.55	564.33	407.81	437.90	44.06	47.00	41.94	44.33	11.38	17.63	21.75	16.92	131.85	160.11	115.92	135.96
T4	2669.52	2684.40	2725.50	2693.14	326.72	478.61	448.44	417.92	46.56	47.63	43.38	45.86	12.00	14.88	15.38	14.09	202.72	176.26	170.31	183.10
T5	2601.50	2676.48	2660.76	2646.25	296.34	474.04	436.44	402.27	43.06	46.63	42.63	44.11	11.06	17.56	16.41	15.01	150.23	159.21	168.44	159.29
T6	2636.24	2642.93	2652.08	2643.75	291.15	459.32	388.31	379.59	45.56	45.31	40.88	43.92	12.35	15.19	14.13	13.89	126.79	160.11	167.48	151.46
Mean	2589.34	2642.96	2656.54		315.16	515.04	471.81		45.08	47.45	43.04		12.14	16.08	19.19		144.62	166.90	163.85	

	CD (P = 0.05)									
T	76.25		72.41		NS		1.62		9.49	
D	53.92		51.20		2.91		1.15		6.71	
T x D	NS		125.42		NS		2.81		16.45	
CV%	3.54		12.03		11.09		12.53		7.31	

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

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