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RESEARCH PAPER

Effect of split application of the major nutrients through fertigation on nutrients dynamics in groundnut crop under northern dry zone of Karnataka

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Abstract: A field experiment was carried out at IWMRC, Arabhavi, Gokak, during 2024 "Effect of split application of the major nutrients through fertigation on nutrients dynamics in groundnut crop under Northern Dry Zone of Karnataka". The design was Randomized Complete Block Design with 10 treatment combinations with different level *viz.* 100 per cent and 75 per cent of RDF applied through fertigation by use of water soluble fertilizers in different splits compared to basal application of conventional fertilizer. Results revealed that application of 25 per cent of RDF as basal and 75 per cent of recommended dose of N, P and K through fertigation recorded significantly higher yield (35.8 q ha^{-1}), net return (₹ 132105 ha^{-1}) and B: C ratio (2.20) andsignificantly higher uptake of N, P and K (270.9 kg ha^{-1}, 34.5 kg ha^{-1} and 101.7 kg ha^{-1} respectively) were recorded. Significantly higher available N, P and K status after harvest of crop was observed with 100 per cent of RDF applied by conventional fertilizer and method. Application of 25 per cent of RDF of NPK as basal and 75 per cent of RDF of NPK through fertigation results in minimal nutrient losses and favourable nutrient uptake during different growth stages in groundnut crop.

Key words: Nutrients dynamics, Nutrient uptake, Split application, Water soluble fertilizers

Introduction

Over the past fifty years, Indian agriculture has undergone major changes driven by technological advancements. The Green Revolution played a key role by introducing high yielding varieties, fertilizers and irrigation, which greatly boosted food production (Pingali *et al*., 2012). However, over time, heavy dependence on these methods led to stagnating yields. A promising alternative is the use of Water-Soluble Fertilizers, which improve nutrient uptake, enhance fertilizer use efficiency and support higher productivity with reduced environmental impact.

Fertigation has significantly altered the nutrient dynamics of soil, particularly for nitrogen, phosphorus and potassium, by enhancing their availability and uptake efficiency. Nitrogen losses due to leaching and volatilization are reduced, ensuring a sustained supply in root zone. Phosphorus, prone to fixation in soil, remains more soluble and accessible. Potassium distribution is more uniform, preventing localized deficiencies and maintaining nutrient balance. Additionally, fertigation minimizes nutrient runoff and enhances fertilizer use efficiency, contributing to higher crop productivity and long-term soil health (Singh *et al*., 2020).

Groundnut (*Arachis hypogaea* L.), often called the "poor man's almond," is an important legume of the family Leguminosae. Globally, it is the fourth major source of edible oil and the third leading source of plant-based protein, with seeds containing 40–45% oil, 25% protein, 18% carbohydrates, and essential minerals and vitamins. It is cultivated on 24.59 m ha worldwide, producing 40.47 million tonnes with an average productivity of 1640 kg ha^{-1}. In India, as per the second advance estimates (2022–23), groundnut covered 5.53 m ha with a production of 7.4 million tonnes and productivity of 1338 kg ha^{-1}. In Karnataka, the crop occupied 47,443 ha, with a production of 404,810 tonnes and productivity of 871 kg ha^{-1} during 2022–23. Belagavi district ranked sixth in area, production, and productivity of groundnut.

Groundnut production is often uncertain, with fluctuating pod and oil yields. Rising input and labour costs emphasize the need for efficient resource use. Precision water and nutrient management, particularly through drip fertigation with varied fertilizer sources and levels, can minimize losses while improving water use efficiency and nutrient uptake (Shukla *et al*., 2020).

Material and methods

The experiment was conducted at Irrigation Water Management Research Centre (IWMRC), Arabhavi, Gokak taluk of Belgavi district which is situated in the Northern Dry Zone (Zone-3) of Karnataka.The soil was classified as clayey loam in texture. The crop grown wasgroundnut of variety Dh 256. The trial was laid out in a Randomized Complete Block Design (RCBD) with 10 treatments (Table 1) replicated three times.

Table 1. Treatment details of the experimental plot

T_1	100% RDN fertigation with 100% RDP & K basal
T_2	100% RDN & K fertigation with 100% RDP basal
T_3	100% RDN, P & K fertigation with no basal
T_4	25% RDNPK as basal and 75% RDNPK fertigation
T_5	75% RDN fertigation with 75% RDP & K basal
T_6	75% RDN & K fertigation with 75% RDP basal
T_7	75% RDN, P & K fertigation with no basal
T_8	19% RDNPK as basal and 56% RDNPK fertigation
T_9	100% RDNPK through conventional fertilizers and method
T_{10}	Absolute control (No fertilizer)*RD: Recommended

dose, *N: Nitrogen, *P: Phosphorous,*K: Potassium

Fertigation was imposed every week, soil samples were collected at every fertigation interval at different days after sowing until harvest, which lead to soil sampling for 11 times (7 DAS, 15 DAS, 23 DAS, 31 DAS, 39 DAS, 47 DAS, 55 DAS, 63 DAS, 71 DAS, 79 DAS and after harvest) from each treatment. Five plants in each treatment were randomly selected in each plot and tagged for recording growth and yield parameters.

Soil pH was measured using glass electrode pH meter after stirring for 30 minutes at 25°C, following the method by Sparks (1996). Electrical conductivity was determined in supernatant solution using conductivity meter, expressed in dS/m. OC content was determined by Walkley and Black method, as per Sparks (1996). Available nitrogen was measured using Alkaline permanganate oxidation method (Sharawat and Burford, 1982). Available phosphorus was extracted using Olsen's method and estimated spectrophotometrically. Available potassium was extracted by shaking soil samples with neutral normal ammonium acetate and K content was determined using flame photometer. Available sulphur was extracted with 0.15% CaCl, 2H,O and its content was measured turbidimetrically using spectrophotometer, according to Jackson (1973).

Results and discussion

Table 2 highlights substantial differences in all yield components of groundnut under varying fertigation regimes. The T_4 treatment (25% RDNPK basal + 75% fertigation) achieved the highest values for nodules per plant (53.1), effective nodules (52.8), pods per plant (83.8), seed yield per plant (63.5 g), test weight (45.1 g), pod yield (35.8 q ha^{-1}), and haulm yield (59.0 q ha^{-1}).Whereas, absolute control (T_{10}) consistently showed the lowest values across all traits, including nodules per plant (25.3), pods per plant (29.6) and pod yield (17.2 q ha^{-1}), confirming the detrimental effect of nutrient omission (Chinchali *et al*., 2020). The superiority of T_4 is attributed to the synchronized and adequate nutrient supply meeting the crop's requirements at critical stages, enhancing nodulation, pod formation and seed development (Kumara *et al*., 2025).

Table 2. Effect of split application of major nutrients through fertigation on yield parameters of groundnut

Treatment detail	No. of nodules /plant	No. of effective nodules/plant	No.of pods/ plant	Seed yield/ plant(g)	Test weight (g)	Pod Yield (q ha^{-1})	Haulm yield (q ha^{-1})
T_1: 100% RDN fertigation with 100% RDP & K basal	48.5	47.1	74.3	58.0	42.8	32.1	53.0
T_2: 100% RDN & K fertigation with 100% RDP basal	49.3	47.5	74.4	60.0	42.6	32.7	54.0
T_3: 100% RDN, P & K fertigation with no basal	48.2	47.3	76.5	61.3	43.8	32.8	54.2
T_4: 25% RDNPK as basal and 75% RDNPK fertigation	53.1	52.8	83.8	63.5	45.1	35.8	59.0
T_5: 75% RDN fertigation with 75% RDP & K basal	44.7	41.2	71.0	53.8	41.8	29.7	49.0
T_6: 75% RDN & K fertigation with 75% RDP basal	45.4	41.7	72.8	54.0	42.0	30.7	50.6
T_7: 75% RDN, P & K fertigation with no basal	45.8	42.1	73.3	55.4	42.4	31.3	51.6
T_8: 19% RDNPK as basal and 56% RDNPK fertigation	48.7	47.9	74.9	57.8	43.1	32.9	54.2
T_9: 100% RDNPK through conventional fertilizers and method (Control)	38.3	32.3	52.9	45.4	40.6	27.9	46.0
T_{10}: Absolute control (No fertilizer)	25.3	20.4	29.6	30.4	38.2	17.2	28.4
S E.m ±	1.1	1.4	1.0	0.7	0.9	1.3	2.1
C.D @ 5%	3.4	4.3	2.9	2.2	2.7	3.8	6.2

*RD: Recommended dose, *N: Nitrogen, *P: Phosphorous,*K: Potassium

Table 3. Effect of split application of major nutrients through fertigation on periodical changes of soil pH in groundnut

Treatment	7 DAS	15 DAS	23 DAS	31 DAS	39 DAS	47 DAS	55 DAS	63 DAS	71 DAS	79 DAS	125 DAS
T_1	8.36	8.33	8.25	8.13	7.85	7.77	7.74	7.73	7.77	8.12	8.26
T_2	8.35	8.32	8.22	8.15	7.83	7.75	7.73	7.72	7.73	7.89	8.23
T_3	8.34	8.36	8.26	8.17	7.82	7.74	7.71	7.71	7.71	7.86	8.22
T_4	8.33	8.33	8.20	8.09	7.79	7.73	7.70	7.69	7.68	7.83	8.20
T_5	8.45	8.43	8.34	8.22	7.82	7.81	7.73	7.75	7.83	7.98	8.35
T_6	8.44	8.42	8.33	8.22	7.83	7.79	7.75	7.75	7.83	7.94	8.29
T_7	8.43	8.40	8.34	8.21	7.83	7.79	7.71	7.71	7.76	7.92	8.26
T_8	8.42	8.40	8.34	8.20	7.83	7.90	8.08	8.08	8.12	7.89	8.22
T_9	8.55	8.53	8.53	8.50	8.43	8.39	8.23	8.27	8.49	8.51	8.45
T_{10}	8.65	8.60	8.62	8.60	8.57	8.54	8.50	8.37	8.60	8.63	8.55
S E.m ±	0.05	0.08	0.04	0.05	0.08	0.07	0.2	0.11	0.04	0.11	0.04
C.D @ 5%	0.20	NS	0.12	0.15	0.30	0.22	0.5	0.32	0.13	0.33	0.12

*DAS: Days after Sowing.

T_1: 100% RDN fertigation with 100% RDP & K basal
T_2: 100% RDN & K fertigation with 100% RDP basal
T_3: 100% RDN, P & K fertigation with no basal
T_4: 25% RDNPK as basal and 75% RDNPK fertigation
T_5: 75% RDN fertigation with 75% RDP & K basal
T_6: 75% RDN & K fertigation with 75% RDP basal
T_7: 75% RDN, P & K fertigation with no basal
T_8: 19% RDNPK as basal and 56% RDNPK fertigation
T_9: 100% RDNPK through conventional fertilizers and method (Control)
T_{10}: Absolute control (No fertilizer)

Table 4.Effect of split application of major nutrients through fertigation on periodical changes of soil EC (dS m^{-1}) in groundnut

Treatment	7 DAS	15 DAS	23 DAS	31 DAS	39 DAS	47 DAS	55 DAS	63 DAS	71 DAS	79 DAS	125 DAS
T_1	0.51	0.50	0.49	0.48	0.45	0.43	0.40	0.38	0.36	0.37	0.52
T_2	0.49	0.44	0.43	0.42	0.42	0.41	0.38	0.37	0.37	0.39	0.49
T_3	0.42	0.42	0.42	0.41	0.40	0.39	0.37	0.35	0.35	0.35	0.45
T_4	0.41	0.41	0.39	0.39	0.38	0.38	0.35	0.34	0.32	0.33	0.43
T_5	0.56	0.56	0.54	0.53	0.52	0.52	0.50	0.43	0.39	0.39	0.50
T_6	0.54	0.55	0.55	0.52	0.50	0.49	0.48	0.41	0.36	0.35	0.51
T_7	0.54	0.53	0.53	0.51	0.50	0.48	0.45	0.38	0.35	0.33	0.49
T_8	0.53	0.51	0.50	0.49	0.53	0.43	0.42	0.36	0.33	0.31	0.48
T_9	0.65	0.62	0.61	0.60	0.63	0.55	0.52	0.50	0.49	0.48	0.55
T_{10}	0.66	0.65	0.66	0.66	0.65	0.57	0.63	0.58	0.61	0.63	0.66
S E.m ±	0.01	0.01	0.05	0.02	0.03	0.01	0.01	0.02	0.03	0.04	0.03
C.D @ 5%	0.04	0.03	0.14	0.06	0.07	0.04	0.03	0.06	0.10	0.11	0.10

*DAS: Days after Sowing.

T_1: 100% RDN fertigation with 100% RDP & K basal
T_2: 100% RDN & K fertigation with 100% RDP basal
T_3: 100% RDN, P & K fertigation with no basal
T_4: 25% RDNPK as basal and 75% RDNPK fertigation
T_5: 75% RDN fertigation with 75% RDP & K basal
T_6: 75% RDN & K fertigation with 75% RDP basal
T_7: 75% RDN, P & K fertigation with no basal
T_8: 19% RDNPK as basal and 56% RDNPK fertigation
T_9: 100% RDNPK through conventional fertilizers and method (Control)
T_{10}: Absolute control (No fertilizer)

Table 5. Effect of split application of major nutrients through fertigation on periodical changes of soil organic carbon (%) in groundnut

Treatment	7 DAS	15 DAS	23 DAS	31 DAS	39 DAS	47 DAS	55 DAS	63 DAS	71 DAS	79 DAS	125 DAS
T_1	0.49	0.51	0.51	0.52	0.53	0.57	0.59	0.60	0.63	0.64	0.60
T_2	0.52	0.54	0.54	0.55	0.57	0.58	0.60	0.62	0.65	0.66	0.63
T_3	0.53	0.55	0.55	0.57	0.59	0.60	0.63	0.65	0.68	0.67	0.64
T_4	0.54	0.56	0.58	0.59	0.61	0.63	0.65	0.67	0.70	0.69	0.66
T_5	0.47	0.50	0.51	0.52	0.53	0.53	0.58	0.59	0.60	0.61	0.58
T_6	0.49	0.51	0.52	0.55	0.55	0.55	0.61	0.62	0.63	0.65	0.60
T_7	0.52	0.53	0.54	0.55	0.57	0.57	0.63	0.64	0.65	0.67	0.61
T_8	0.52	0.54	0.56	0.57	0.58	0.58	0.61	0.67	0.68	0.70	0.62
T_9	0.48	0.49	0.46	0.47	0.49	0.50	0.53	0.54	0.55	0.52	0.52
T_{10}	0.43	0.46	0.43	0.44	0.45	0.46	0.42	0.47	0.47	0.45	0.43
S. Em±	0.02	0.02	0.01	0.02	0.01	0.01	0.02	0.01	0.01	0.02	0.02
C.D @ 5%	0.04	0.05	0.04	0.04	0.04	0.04	0.05	0.03	0.04	0.05	0.06

*DAS: Days after Sowing.

T_1: 100% RDN fertigation with 100% RDP & K basal
T_2: 100% RDN & K fertigation with 100% RDP basal
T_3: 100% RDN, P & K fertigation with no basal
T_4: 25% RDNPK as basal and 75% RDNPK fertigation
T_5: 75% RDN fertigation with 75% RDP & K basal
T_6: 75% RDN & K fertigation with 75% RDP basal
T_7: 75% RDN, P & K fertigation with no basal
T_8: 19% RDNPK as basal and 56% RDNPK fertigation
T_9: 100% RDNPK through conventional fertilizers and method (Control)
T_{10}: Absolute control (No fertilizer)

Significant variations in soil pH were recorded among treatments (Table 3). The absolute control (T_{10}) had higher pH (8.65 at 7 DAS), declining slightly to 8.55 after harvest, reflecting minimal acidification in absence of fertilizer input (Wang *et al.*, 2022). The lowest pH (8.22) was observed in T_8 (19% RDNPK basal + 56% RDNPK fertigation), showing greater acidification due to nutrient solubilization and nitrification under fertigation (Zhang *et al.*, 2020). The conventional fertilizer treatment (T_9) maintained a relatively higher pH (8.45) than fertigation treatments, indicating that split application of nutrients through fertigation led to stronger acidifying effects.

Soil electrical conductivity differed significantly among treatments (Table 4). The absolute control (T_{10}) consistently had the highest EC (0.66 dS m^{-1}) from 7 DAS to after harvest, indicating minimal nutrient addition and stable ionic content. The lowest EC (0.48 dS m^{-1}) was measured in T_8 (19% RDNPK basal + 56% RDNPK fertigation) after harvest, reflecting greater nutrient uptake and reduced salinity accumulation. The conventional fertilizer treatment (T_9) showed intermediate EC (0.55 dS m^{-1}), indicating moderate residual salts compared to fertigation. Results indicate that split fertigation enhances nutrient use efficiency and decreases soil salinity relative conventional methods (Basava *et al.*, 2012).

The data in Table 5 shows significant differences in soil organic carbon. The highest SOC at harvest (0.66%) was recorded in T_4 (25% RDNPK basal + 75% fertigation). Among the 75% fertigation treatments, T_8 attained the highest SOC (0.62 %). The lowest SOC throughout was observed in absolute control (T_{10}) at 0.43%, with little change during the crop cycle. This indicates that fertigation and basal nutrient integration enhance SOC accumulation likely due to increased root biomass and microbial activity (Li *et al.*, 2019) and (Chen *et al.*, 2021).

The data in Table 6 shows significant variations in soil available nitrogen. T_4 (25% RDNPK basal + 75% fertigation)

Table 6.Effect of split application of major nutrients through fertigation on periodical mineralization of soil available N (kg ha^{-1}) in groundnut crop

Treatment	7 DAS	15 DAS	23 DAS	31 DAS	39 DAS	47 DAS	55 DAS	63 DAS	71 DAS	79 DAS	125 DAS
T_1	225.5	231.6	238.6	252.4	255.6	258.9	259.7	266.6	271.0	279.4	248.6
T_2	235.4	239.2	244.4	242.1	247.5	257.0	260.9	268.5	269.8	277.8	254.4
T_3	215.6	210.6	205.6	204.4	220.1	228.9	229.8	231.2	244.6	264.7	245.6
T_4	258.7	265.7	273.6	279.1	283.7	288.3	294.0	299.6	303.3	313.9	275.6
T_5	220.3	219.7	229.7	240.8	243.7	246.1	249.2	255.9	266.5	272.9	230.7
T_6	210.4	200.8	225.4	234.8	240.8	243.7	251.8	259.3	267.7	277.6	235.5
T_7	205.5	198.7	196.7	189.5	202.1	209.9	215.3	224.9	225.4	246.6	238.7
T_8	225.4	229.4	235.3	243.7	249.6	257.4	266.2	266.0	274.4	283.4	245.3
T_9	293.4	302.5	313.6	286.6	278.7	271.4	266.4	238.4	264.4	265.8	216.9
T_{10}	175.1	170.5	173.5	171.8	171.6	175.8	177.3	179.5	177.7	184.2	175.5
S E.m ±	1.5	4.6	4.2	4.4	5.3	5.1	3.0	3.5	1.9	3.1	2.5
C.D @ 5%	4.6	13.7	12.7	13.2	15.8	15.2	8.8	10.5	5.8	9.3	7.4

*DAS: Days after Sowing.

T_1: 100% RDN fertigation with 100% RDP & K basal
T_2: 100% RDN & K fertigation with 100% RDP basal
T_3: 100% RDN, P & K fertigation with no basal
T_4: 25% RDNPK as basal and 75% RDNPK fertigation
T_5: 75% RDN fertigation with 75% RDP & K basal
T_6: 75% RDN & K fertigation with 75% RDP basal
T_7: 75% RDN, P & K fertigation with no basal
T_8: 19% RDNPK as basal and 56% RDNPK fertigation
T_9: 100% RDNPK through conventional fertilizers and method (Control)
T_{10}: Absolute control (No fertilizer)

Table 7.Effect of split application of major nutrients on periodical mineralization of P (Kg ha^{-1}) in groundnut crop

Treatment	7 DAS	15 DAS	23 DAS	31 DAS	39 DAS	47 DAS	55 DAS	63 DAS	71 DAS	79 DAS	125 DAS
T_1	35.6	37.7	40.3	41.5	37.1	40.1	37.2	35.7	34.5	30.7	26.7
T_2	34.8	33.5	36.6	37.2	37.6	34.3	33.6	32.1	31.8	28.5	25.0
T_3	26.7	25.2	24.0	26.6	28.4	29.2	30.4	33.5	34.4	35.6	30.4
T_4	28.5	30.2	33.1	38.0	37.8	39.7	43.8	45.6	46.3	44.7	40.4
T_5	31.9	33.2	36.1	38.4	34.6	32.4	30.5	30.2	29.1	26.2	23.2
T_6	30.4	33.5	33.6	34.9	33.2	31.0	31.0	27.8	25.7	26.6	24.1
T_7	23.2	21.4	23.2	21.3	26.3	26.2	28.7	28.6	32.1	34.8	30.7
T_8	26.7	26.9	29.1	31.3	33.3	35.8	37.9	38.8	41.5	41.2	33.8
T_9	36.7	37.5	37.4	39.5	39.2	38.3	35.5	33.2	30.9	27.8	22.8
T_{10}	18.4	17.4	18.0	18.1	18.5	17.3	17.0	17.8	16.3	16.4	15.4
S E.m ±	1.3	2.5	1.1	1.0	1.3	2.1	1.4	0.9	1.8	1.0	1.4
C.D @ 5%	3.9	7.4	3.3	3.4	3.8	6.2	4.3	2.6	5.3	3.1	4.3

*DAS: Days after Sowing.

T_1: 100% RDN fertigation with 100% RDP & K basal
T_2: 100% RDN & K fertigation with 100% RDP basal
T_3: 100% RDN, P & K fertigation with no basal
T_4: 25% RDNPK as basal and 75% RDNPK fertigation
T_5: 75% RDN fertigation with 75% RDP & K basal
T_6: 75% RDN & K fertigation with 75% RDP basal
T_7: 75% RDN, P & K fertigation with no basal
T_8: 19% RDNPK as basal and 56% RDNPK fertigation
T_9: 100% RDNPK through conventional fertilizers and method (Control)
T_{10}: Absolute control (No fertilizer)

maintained higher available N in later stages, peaking at 313.9 kg ha^{-1} at 79 DAS and recording the highest harvest value (275.6 kg ha^{-1}). The lowest N content was noted in the absolute control (T_{10}), remaining near 175 kg ha^{-1} (Nackley *et al*., 2024). It indicates that fertigation sustains higher soil N levels, due to improved synchronization between nutrient supply and plant demand.

Significant differences in soil available phosphorus were observed (Table 7). T_4 (25% RDNPK basal + 75% fertigation) recorded the highest P content, peaking at 46.3 kg ha^{-1} at 71 DAS and maintaining 40.4 kg ha^{-1} at harvest. The control (T_{10}) showed the lowest P, declining from 18.4kg ha^{-1} to 15.4 kg ha^{-1} by harvest (Xaxiri *et al.* 2024). These trends indicate that split fertigation with basal doses increases soil P availability at critical growth stages, enhancing nutrient uptake and crop performance.

Significant differences in soil available potassium were observed (Table 8). The conventional 100% NPK treatment (T_9) showed the highest K content early in the season, peaking at 466.1 kg ha^{-1}at 23 DAS but declining to 413.3 kg ha^{-1}at harvest. Among fertigation treatments, T_4 (25% basal + 75% fertigation) maintained high K levels, finishing with 442.3 kg ha^{-1} at harvest, The lowest K content was consistently found in control (T_{10}), declining from 378.5kg ha^{-1} to 325.5 kg ha^{-1}. These results indicatethat split and timely potassium application improves availability and uptake, enhancing groundnut growth and yield potential (Borah *et al*., 2021).

Conclusion

The study demonstrated that split application of major nutrients through fertigation significantly enhances soil fertility parameters, plant nutrient availability and groundnut yield compared to conventional fertilization and control

Table 8.Effect of split application of major nutrients through fertigation on periodical mineralization of soil available K (kg ha-1) in groundnut crop

Treatment	7 DAS	15 DAS	23 DAS	31 DAS	39 DAS	47 DAS	55 DAS	63 DAS	71 DAS	79DAS	125 DAS
T_1	463.9	464.6	476.3	466.8	467.7	459.2	448.9	436.4	434.8	432.9	430.0
T_2	443.2	455.7	463.4	458.3	461.5	455.1	444.5	433.5	437.0	435.2	434.0
T_3	423.8	425.3	434.5	443.0	441.1	433.5	434.3	438.5	427.3	424.2	424.5
T_4	446.0	462.3	475.5	476.1	465.1	464.7	458.6	449.1	442.7	440.6	442.3
T_5	443.9	445.6	462.4	465.2	448.1	443.8	445.1	437.9	427.5	424.6	424.9
T_6	436.1	440.5	451.2	446.4	445.5	442.1	447.2	438.8	428.8	427.5	427.8
T_7	420.7	425.5	446.4	437.1	441.4	441.7	442.7	434.5	425.3	423.1	424.4
T_8	435.4	445.9	454.7	461.9	454.5	453.5	453.9	445.4	435.5	431.9	427.1
T_9	465.5	461.2	466.1	456.3	444.5	435.8	441.5	438.3	423.9	420.7	413.3
T_{10}	378.5	362.7	357.7	336.4	336.9	354.5	333.9	328.6	327.8	324.8	325.5
S E.m ±	4.7	6.8	6.5	6.6	6.6	7.3	6.1	6.2	2.8	3.7	6.9
C.D @ 5%	14.2	20.4	19.5	19.8	19.6	21.8	18.1	18.3	20.4	11.1	20.7

*DAS: Days after Sowing.

T_1: 100% RDN fertigation with 100% RDP & K basal
T_2: 100% RDN & K fertigation with 100% RDP basal
T_3: 100% RDN, P & K fertigation with no basal
T_4: 25% RDNPK as basal and 75% RDNPK fertigation
T_5: 75% RDN fertigation with 75% RDP & K basal
T_6: 75% RDN & K fertigation with 75% RDP basal
T_7: 75% RDN, P & K fertigation with no basal
T_8: 19% RDNPK as basal and 56% RDNPK fertigation
T_9: 100% RDNPK through conventional fertilizers and method (Control)
T_{10}: Absolute control (No fertilizer)

treatments. The treatment combining 25% basal RDNPK with 75% fertigation (T_4) consistently outperformed others, showing superior nodulation, pod and haulm yields, and maintaining higher soil organic carbon, pH balance, and nutrient content (N, P, K) throughout the crop cycle. These improvements are attributed to the precise timing and synchronization of nutrient supply with crop demand, promoting efficient nutrient uptake, reduced soil salinity, and improved soil biological activity. The results validate fertigation as a sustainable and effective nutrient management strategy for optimizing groundnut productivity in semi-arid regions.

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