EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON GROWTH, YIELD, QUALITY OF GROUNDNUT (*ARACHIS HYPOGAEA* L.), NUTRIENT UPTAKE AND SOIL FERTILITY IN SEMIARID TRACT OF SOUTHERN TAMIL NADU OF INDIA

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Abstract. A field experiment was conducted to study the integrated nutrient management on growth and yield of groundnut (*Arachis hypogaea* L.) during *Rabi* season of (September to December) 2019 and 2020 at Agricultural College and Research Institute, Killikulam, Thoothukudi district, Tamil Nadu, India with the test crop of groundnut variety TMV (Gn) 13. The 10 treatments consisted of 2 levels of soil test crop response (STCR) recommended fertilizers (STCR i.e. 38:64:94 NPK kg ha^{-1} (75 and 100%), 3 organic manures (Poultry manure @ 3 t ha^{-1}, Humic acid @ 20 kg ha^{-1} and Rhizobium @ 3 kg ha^{-1}) along with absolute control receiving no organic or fertilizers. The result revealed that application of 75% STCR + Rhizobium @ 3 kg ha^{-1} + Humic acid @ 20 kg ha^{-1} + Poultry manure @ 3 t ha^{-1} (T_8) increased growth and yield attributes that led to significantly higher productivity (2964 and 8975 kg ha^{-1} of mean pod and haulm yield) and nutrient uptake of groundnut besides enriching soil available nutrients after harvest of groundnut. Due to the cheap cost of manuring, that treatment also recorded the highest mean net returns (Indian Rupee (INR) as ₹ (72,706 ha^{-1}) and B:C ratio (2.47).
Keywords: *available nutrients, growth parameters, organic manure, inorganic fertilizers, yield attributes, economics*

Introduction

Groundnut (*Arachis hypogaea* L.) crop is native to South America. It is grown all over the world and commonly known as *'King of Oilseeds'*. It is an excellent source of nutrition to both human and animal due to its high protein content. At world level groundnut is the fourth major edible oil source and third major vegetable protein to human population. Seeds of groundnut composed on an average of 50% oil, 25% protein, 20% starch and 5% minerals and fiber, thus it considered a rich nutritional source to humans. In the world, it is cultivated over an area of 29.5 million ha with production and productivity of 48.5 million tons and 1647 kg ha^{-1} respectively. In India, it occupies an area of 4.9 million ha and production of 10.12 million tons with a productivity of 2060 kg ha^{-1} (GOI, 2021).

Tamil Nadu ranks third in the country with an area of 346.6 lakh ha contributing 6.48% and production of 892.3 lakh tons contributing 14.12% with an average productivity of 2.57 t ha^{-1} (GOI, 2021). To enhance the productivity of groundnut, the location specific nutrient management technique is to be followed not only to achieve the production but also to maintain the sustainability of soil. High productivity through intensification is the primary goal of agronomic research. But to sustain high productivity over a long period, soil fertility has to be maintained at fairly high level. Hence, nutrient management strategies should be aimed at achieving the goals of productivity and

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sustainability with minimum cost of organic nutrients. Poultry manure, Humic acid (HA) and Rhizobium spp. contain all the essential plant nutrients and it improves the soil fertility. Regular and imbalanced application of inorganic nutrient sources by omitting organic leads to reduction in soil health besides restricting groundnut productivity and hence it is vital to improve the soil health by enhancing soil organic matter content. The lack of well-decomposed organic sources such as manure from poultry, manure from farms, rhizobium and humic acid contributes to low production. Though many studies have been carried out in groundnut crop, the soil test crop response (STCR) on integrated nutrient management for groundnut in an Alfisols of Tamiraparani tract is lacking. Therefore, a study was undertaken to evaluate the soil test crop response integrated nutrient management package on the growth and yield of groundnut.

Materials and methods

A field experiment was conducted to study the integrated nutrient management on growth and yield of groundnut (*Arachis hypogaea* L.) during *Rabi* season of (September to December) 2019 and 2020 at Agricultural College and Research Institute, Killikulam, Thoothukudi district, Tamil Nadu, India with the test crop of groundnut variety TMV (Gn) 13. The field was located at 80° 46' latitude and 77° 51' longitude. The elevation of the site was 40 m above sea level. The experimental site coming under alluvial Tamiraparani river basin and semiarid condition received 750 and 785 mm, rainfall during 2019 and 2020, respectively. The daily mean maximum and minimum temperatures for the cropping period were 33.3° and 25.4°C during 2019 and 34.4 and 25.6°C during 2020, respectively. The experimental soil's texture was sandy clay loam (Scl). The soil was nearly neutral in reaction (pH 6.79 and 6.82), EC (0.13 and 0.16 dSm^{-1}), low in organic carbon (0.45% and 0.48%), low available N (212 and 218 kg ha^{-1}), medium available P (16.4 and 18.5 kg ha^{-1}) and available K (228 and 215 kg ha^{-1}).

The 10 treatments consisted of combination 2 levels of soil test crop response (STCR) recommended fertilizers (STCR, 38:64:94 NPK kg ha^{-1}) i.e., 75 and 100% and three organic manures, Poultry manure @ 3 t ha^{-1}, Humic acid @ 20 kg ha^{-1} and Rhizobium @ 3 kg ha^{-1} along with absolute control that received no manures or fertilizers. The STCR fertilizers and manures as per treatment was applied at sowing. The experiment was laid out in a randomized block design (RBD) with 3 replications. The plot size was 8 × 5 m. The recommended seed rate of 120 kg ha^{-1} was used for the trial. The seeds were sown by hand dibbling at the specified spacing of 30 × 10 cm. The total number of plants per plot were 1333. The seeds were sown on 01.11.2019 and 15.11.2020, respectively for two years. The crop was harvested on 15.02.2020 and 26.02.2021, respectively for the two years. Ten plants were selected randomly in each plot. Then, the selected plants were tagged and used for recording all biometric observations in different growth stages of crop. The fertilizers were applied to the experimental field as per the soil test crop response (STCR). Urea (46% N), single super phosphate (16% P2O5) and muriate of potash (60% K2O) fertilizers were used to supply N, P and K nutrients, respectively. The entire dose of phosphorus, half dose of nitrogen was applied basally, and the remaining half dose of nitrogen and potassium were applied as two equal splits on 25 and 40 days after sowing.

The growth yield attributing characters and yield as well as nutrient uptake were recorded at harvest. The nutrient contents were analyzed and the uptake of nutrients were worked out through prescribed laboratory procedures. The soil available N was analyzed

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as described by Subbiah and Asija (1956), available P (Olsen et al., 1954) and available K by flame photometry with extracting 1 N NH_4OAc (Schollenberger and Simon, 1945). The presence of oil in seeds was extracted by using hexane (B.P 75-80°) and the content of oil was determined by Soxhlets apparatus method (A.O.A.C., 1995). The economics were worked out using market prices of inputs and outputs as given in table. Economics of groundnut by means of cost benefit ratio influenced by organic manures, fertilizers and management practices were calculated by considering the prevailing market price of seeds and inputs used. As suggested by Gomez and Gomez (2010), results of the soil and plant sample analysis have been statistically analyzed. Wherever the comparisons were found at considerably significant, with the critical difference at 5% probability level. Significant comparisons are expressed by the symbol ** for 1% probability level and * for 5% probability level and the non-significant comparisons indicated as NS.

Unit cost of inputs and produce as Indian Rupee (INR) as ₹		
Particulars	**Unit**	**Cost as ₹**
All inputs		
Groundnut seed	1 kg	130.0
Urea	1 kg	6.0
Single super phosphate	1 kg	6.0
Muriate of potash	1 kg	12.0
Gypsum	1 kg	3.0
Farm yard manure	1 ton	500.0
Poultry manure	1 ton	1000.0
Humic acid	1 kg	60.0
Rhizobium	1 packet (200 gm)	6.0
Outputs (produces)		
Groundnut pod	1 kg	30.0
Haulm	1 kg	0.50

Treatment details
T_1 – 100% STCR @ 38:64:94 kg NPK ha^{-1}
T_2 – 75% STCR + Poultry manure @ 3 t ha^{-1}
T_3 – 75% STCR + Rhizobium @ 3 kg ha-^{1}
T_4 – 75% STCR + Humic acid @ 20 kg ha^{-1}
T_5 – 75%STCR + Humic acid @ 20 kg ha^{-1} + Rhizobium @ 3 kg ha^{-1}
T_6 – 75% STCR + Rhizobium @ 3 kg ha^{-1} + Poultry manure @ 3 t ha^{-1}
T_7 – 75% STCR + Humic acid @ 20 kg ha^{-1} + Poultry manure @ 3 t ha^{-1}
T_8 – 75% STCR + Rhizobium @ 3 kg ha^{-1} + 20 kg ha^{-1} humic acid + Poultry manure @ 3 t ha^{-1}

Results and discussion

Growth attributes

Among treatments, 75% STCR + Rhizobium @ 3 kg ha^{-1} + Humic acid @ 20 kg ha^{-1} + Poultry manure @ 3 t ha^{-1} (T_8) recorded the tallest plant (67.2 cm) and minimum days (31.1 days) required to 50% flowering during both years. Integration of humic acid and

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poultry manure with 75% STCR fertilizers markedly enhanced the plant height and days to 50% flowering over 100% STCR fertilizers alone or poultry manure alone. The use of three organic sources as rhizobium, humic acid and poultry manure with 75% STCR fertilizer recorded significantly higher plant height and minimum days required to 50% flowering among all treatments, while unfertilized absolute control has the poor performance of these parameters. The integrated sources of nutrients through fertilizers and organics might have increased plant height and minimum days required for 50% flowering. The organic sources of nutrients improved crop growth during later stages. The favorable effect of poultry manure, rhizobium and humic acid on growth might be attributed to presence of relatively readily available plant nutrients, growth enhancing substances and number of beneficial organisms like nitrogen fixing, phosphate solubilizing, cellulose decomposing and other beneficial microbes as well as antibiotics, vitamins and hormones etc. Thus, favorable influence of nutrients to produce larger cells with thinner cell wall and its contribution in cell division and cell elongation which improved vegetative growth and ultimately increased plant height, plant spread, number of branches per plant, root length and number and dry weight of root nodules per plant. The findings are close with findings of Rahevar et al. (2015) and Sengupta et al. (2016). Similar findings were reported earlier by Khaim et al. (2013) and Partha and Sinha (2014). The association of nutrients from inorganics and organics produced more number of leaves with height of plants. Particularly association of nitrogen nutrients with cell division and photosynthesis might have helped the plants to produce more leaves. This is in accordance with the findings of Choudhary et al. (2017) and Thakur et al. (2018). The increase in plant height and more leaves resulted in significant increase dry matter production (DMP). Rhizobium, humic acid and poultry manure with 75% STCR fertilizer recorded significantly higher DMP than all other treatments (8854 kg ha^{-1}, means of 2 years).

Yield attributes

The different organics with 75% STCR recommended fertilizers had significant influence on the pods $plant^{-1}$, 100 pods weight and 100 kernels weight (*Table 1*). Application of 75% STCR + Rhizobium @ 3 kg ha^{-1} + Humic acid @ 20 kg ha^{-1} + Poultry manure @ 3 t ha^{-1} (T_8) recorded the maximum number of pods $plant^{-1}$ (67.4), 100 pods weight (71.2 g) and100 kernels weight (36.4 g) and over rest of the treatments in both years while absolute control resulted in lowest values of pods $plant^{-1}$ (26.4), 100 pods weight (27.8 g) and 100 kernels weight (31.4 g). Application of 75% STCR + Rhizobium + Humic acid + Poultry manure might have promoted higher growth rate from the early stage onwards in terms of plant height, pod weight, kernel weight as well as dry matter production. Thus, the optimum growth of the plant due to favorable nutritional environment and higher uptake of nutrients might have favored significant increase in number of pegs $plant^{-1}$ and thus more number of pods $plant^{-1}$. Increased values in these yield attributes might have been on account of the overall improvement in vegetative growth and nodulation, which favorably influenced the flowering and fruiting and ultimately resulted into increased number of matured pods and pod weight per plant. These findings agreement with the results obtained by Chaudhary et al. (2015), Bala and Nath (2015). This is in agreement with the findings of Falodun et al. (2015) and Aruna and Karuna Sagar (2018). 75% STCR + Rhizobium + Humic acid + Poultry and 75% STCR + Humic acid + Poultry are at on par with each other during both the years of study.

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Table 1. *Effect of integrated nutrient management on growth and yield attributes of groundnut*

Treatment	Plant height (cm)		Days to 50% flowering		Dry matter production (kg/ha)		Pods/plant		100 Pods weight/plant (g)		100 Kernel weight (g)	
	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
T_1 – 100% STCR @ 38:64:94 kg NPK ha^{-1}	53.2	55.4	35.6	35.2	7273	7321	45.7	46.8	49.7	47.7	31.3	31.8
T_2 – 75% STCR + Poultry manure @ 3 t ha^{-1}	54.4	56.8	36.6	35.7	6527	6585	36.6	35.4	38.6	39.6	32.8	33.1
T_3 – 75% STCR + Rhizobium @ 3 kg ha-^{1}	53.8	54.7	36.6	35.4	6828	6848	34.5	35.6	43.1	43.5	33.4	33.8
T_4 – 75% STCR + Humic acid @ 20 kg ha^{-1}	49.7	50.5	35.6	34.3	7317	7340	39.6	40.7	44.4	46.2	32.7	33.4
T_5 – 75% STCR + Humic acid @ 20 kg ha^{-1} + Rhizobium @ 3 kg ha^{-1}	58.0	60.3	34.6	34.0	8201	8254	51.8	52.3	59.5	60.5	34.3	35.0
T_6 – 75% STCR + Rhizobium @ 3 kg ha^{-1} + Poultry manure @ 3 t ha^{-1}	47.2	48.2	38.6	37.8	6373	6387	48.8	50.2	57.0	58.8	33.4	33.7
T_7 – 75% STCR + Humic acid @ 20 kg ha^{-1} + Poultry manure @ 3 t ha^{-1}	58.8	62.2	31.5	32.0	8678	6701	52.9	53.4	62.0	62.7	35.5	36.1
T_8 – 75% STCR + Rhizobium @ 3 kg ha^{-1} + Humic acid @ 20 kg ha^{-1} + Poultry manure @ 3 t ha^{-1}	66.6	67.8	30.5	31.8	8821	8888	66.1	68.8	70.9	71.6	36.0	36.8
T_9 - Poultry manure @ 3 t ha^{-1}	54.5	55.5	34.6	34.2	5277	5271	40.7	40.2	56.0	55.1	33.4	33.3
T_{10}- Absolute control.	44.6	45.5	39.6	38.7	4753	4706	25.4	27.3	27.0	28.6	31.3	31.5
SEd	0.50	0.51	0.31	0.32	148.67	146.52	0.72	0.77	0.79	0.81	0.074	0.078
CD (P = 0.05)	1.06	1.07	0.65	0.64	312.35	315.32	1.51	1.53	1.67	1.69	0.156	0.157

Yield

The nutrient management practices had significant influence on pod and haulm yield of groundnut during both the years (*Table 2*). The pod and haulm yield were significantly higher (2964 and 8975 kg ha^{-1}, respectively) at 75% STCR + Rhizobium @ 3 kg ha^{-1} + Humic acid @ 20 kg ha^{-1} + Poultry manure @ 3 t ha^{-1} (T_8). This was followed by 75% STCR + Humic acid @ 20 kg ha^{-1} + Poultry manure @ 3 t ha^{-1} (T_7) and they were on par with each other. The absolute control recorded the lowest pod and haulm yields (1522 and 4849 kg ha^{-1}, respectively). Application of 75% STCR + Rhizobium + Humic acid + Poultry manure increased the pod and haulm yields significantly over all other treatments during both the years. However, the haulm yield of 75% STCR + Rhizobium + Humic acid + Poultry manure and 75% STCR + Humic acid + Poultry manure in both years were at on par. Higher pod yield could be attributed to favorable changes in physical and chemical characteristics of the soil which might have enable better pod formation. Moreover, the positive influence of these treatments through immediate supply of nutrients from inorganic sources especially at early stage of the crop and slow and steady supply of nutrients from poultry manures, rhizobium and humic acid throughout the crop growth period might have improved adequate biomass production and improvement in yield parameters resulting in higher pod and haulm yield. The increased in kernel weight and shelling, this might be due to improvement in nutritional environment which might have favorably influenced carbohydrate metabolism which in turn increased the uptake of nutrients and ultimately resulted in increased kernel weight and shelling per cent (Swamy et al., 2019; Vala et

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al., 2018). The earlier report also confirmed the significant increase in pod yield of ground nut due to integrated application of nutrients (Zalate and Padmani, 2009).

Table 2. *Effect of integrated nutrient management on haulm, pod yield and economics (₹ ha^{-1}) of groundnut*

Treatment	Haulm yield (kg/ha)		Pod yield (kg/ha)		Economics Indian Rupee (INR) as ₹					
					2019			2020		
	2019	2020	2019	2020	Cost of cultivation	Net returns	B:C ratio	Cost of cultivation	Net returns	B:C ratio
T_1 – 100% STCR @ 38:64:94 kg NPK ha^{-1}	7396	7405	2464	2505	45,167	57,107	2.26	45,368	56,905	2.28
T_2 – 75% STCR + Poultry manure @ 3 t ha^{-1}	6638	6685	2211	2243	47,567	44,182	1.93	47,895	44,765	1.95
T_3 – 75% STCR + Rhizobium @ 3 kg ha-^{1}	6943	6990	2299	2310	44,362	51,077	2.15	44,743	51,673	2.17
T_4 – 75% STCR + Humic acid @ 20 kg ha^{-1}	7441	7482	2464	2514	45,767	56,509	2.23	46,025	56,810	2.20
T_5 – 75% STCR + Humic acid @ 20 kg ha^{-1} + Rhizobium @ 3 kg ha^{-1}	8515	8575	2669	2655	46,062	64,945	2.41	46,545	65,121	2.38
T_6 – 75% STCR + Rhizobium @ 3 kg ha^{-1} + Poultry manure @ 3 t ha^{-1}	6481	6505	2148	2178	47,862	41,287	1.86	48,127	41,445	1.88
T_7 – 75% STCR + Humic acid @ 20 kg ha^{-1} + Poultry manure @ 3 t ha^{-1}	8825	8877	2775	2835	49,267	66,165	2.34	49,610	66,586	2.37
T_8 – 75% STCR + Rhizobium @ 3 kg ha^{-1} + Humic acid @ 20 kg ha^{-1} + Poultry manure @ 3 t ha^{-1}	8936	9015	2938	2990	49,562	72,433	2.46	49,990	72,980	2.48
T_9 - Poultry manure @ 3 t ha^{-1}	5366	5385	1789	1756	43,509	30,727	1.71	43,712	31,065	1.73
T_{10}- Absolute control.	4834	4865	1530	1515	40,009	23,611	1.59	40,223	23,820	1.47
SEd	85.03	86.07	26.65	26.82						
CD (P = 0.05)	178.65	179.01	56.01	56.07						

Quality

The oil and protein yield was also influenced by the application of STCR recommended NPK with different organic manures (*Figs. 1* and *2*). Application of 75% STCR + Rhizobium @ 3 kg ha^{-1} + Humic acid 20 kg ha^{-1} + Poultry manure @ 3 t ha^{-1} (T_8) recorded the highest oil and protein content (50.24% and 25.72%, respectively) and yield (1014 and 536 kg ha^{-1}) followed by 75% STCR + 20 kg of humic acid ha^{-1} + Poultry manure @ 3 t ha^{-1} (T_7) which registered the next best oil and protein content (49.10 and 25.21%) and yield of 962 and 497 kg ha^{-1}. The absolute control (T_{10}) was recorded the lowest oil and protein yield (348 and 187 kg ha^{-1}). Application of 75% STCR + 3 kg ha^{-1} of Rhizobium + Humic acid @ 20 kg ha^{-1} + Poultry manure @ 3 t ha^{-1} (T_8) provided the significant improvement in the oil and protein yield of groundnut seeds. The increased oil and protein content might be due to the role of nitrogen and humic acid are an integral part of protein and phosphorus is structural element of certain co-enzymes involved in biosynthesis of oil and storage organs, which are proteinaceous in nature. These findings are in close conformity with those reported by Mohanty et al. (2022) and Nagaraj et al. (2018). Eisa. (2011) and Saini et al. (2017) also reported that the humic acid influenced the oil and protein in groundnut. So, the humic acid can be contributed to increasing the yield and similarly improving the oil and protein yield.

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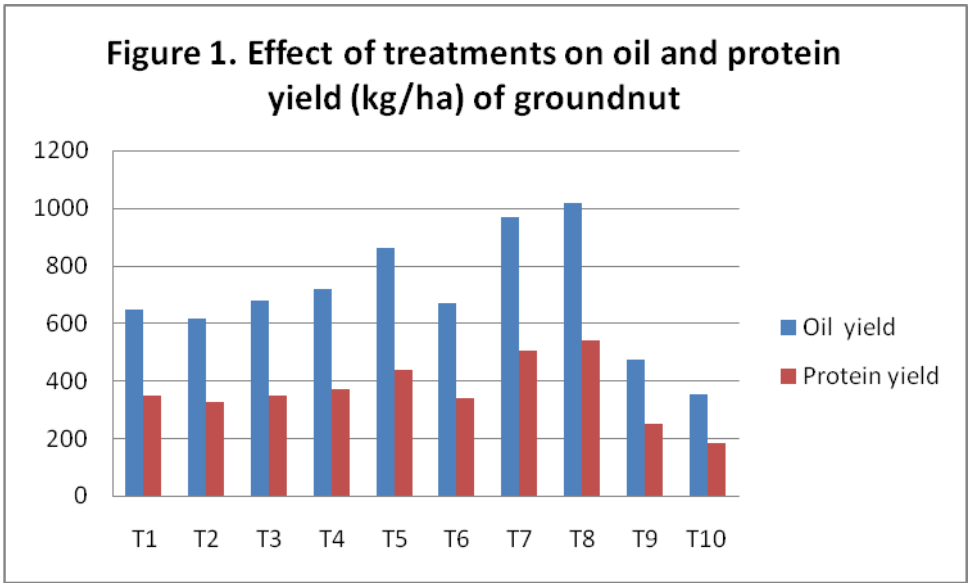

Figure 1. *Effect of treatments on oil and protein yield (kg/ha) of groundnut*

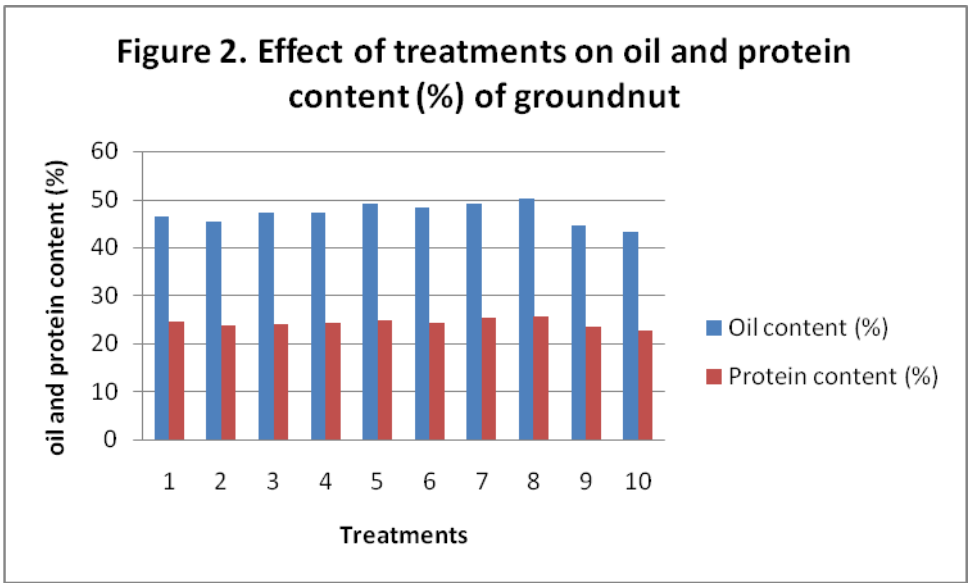

Figure 2. *Effect of treatments on oil and protein content (%) of groundnut*

Nutrient uptake and soil nutrient status

Application of inorganic fertilizers in combination with organic manures had significantly influenced the N, P and K uptake by groundnut crop during both the years of study (*Table 3*). Among the treatments, application of 75% STCR + Rhizobium @ 3 kg ha^{-1} + Humic acid @ 20 kg ha^{-1} + Poultry manure @ 3 t ha^{-1} (T_8) recorded significantly higher N, P and K uptake (195, 22.9 and 166 kg ha^{-1}, respectively) than rest of the treatments. This was followed by 75% STCR + Humic acid @ 20 kg ha^{-1} + Poultry manure @ 3 t ha^{-1} (T_7) (176, 19.9 and 146 kg ha^{-1}, respectively) and they were at on par. The uptake of major nutrients increased with 75% soil test crop responded recommended fertilizers and organic amendments application. Biofertilizers enhanced

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the availability of phosphorus to plants, which might have utilized by the crop in greater root development and nodulation that in turn resulted in higher nitrogen fixation in the soil by nodules. Thus, increased availability of nitrogen and phosphorus might have resulted in greater uptake by the plants for proper development and ultimately increased their content in plants. Similar results were reported by Prasad et al. (2005), Kara et al. (2006) Gunri et al. (2015) and Aruna and Karuna Sagar (2018). Among the different treatments, the inorganic fertilizers alone or organic alone registered lower uptake of N, P and K. The application of 75% soil test crop response recommended fertilizers with organic sources favored higher root and shoot development which might have also increased the uptake of N, P and K. The poultry manures, rhizobium and humic acid besides supplying major and minor plant nutrients, might have influenced the physical properties favorably resulting in better soil structure, greater water retention, more favorable environment for root and pod development ultimately registering increased nutrient uptake (Prathivrajkumar et al. (2023). This is evidenced from the reports of Chitdeswari et al. (2007) and Ravi et al. (2010).

Table 3. *Effect of integrated nutrient management on nutrient uptake of groundnut and nutrient status (kg/ha) of soil after harvest*

Treatment	Plant uptake						Soil available status					
	N		P		K		N		P		K	
	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
T1 – 100% STCR @ 38:64:94 kg NPK ha-1	128	125	14.8	14.1	112	108	237	231	12.4	10.3	241	236
T2 – 75% STCR + Poultry manure @ 3 t ha-1	122	121	13.8	12.6	91	90	231	228	14.1	11.8	230	226
T3 – 75% STCR + Rhizobium @ 3 kg ha-1	118	120	13.3	12.4	96	96	234	230	11.7	9.6	240	235
T4 – 75% STCR + Humic acid @ 20 kg ha-1	133	131	14.9	13.2	99	97	230	228	11.3	8.9	257	253
T5 – 75% STCR + Humic acid @ 20 kg ha-1 + Rhizobium @ 3 kg ha-1	166	163	19.4	18.5	132	131	254	248	13.5	10.7	273	266
T6 – 75% STCR + Rhizobium @ 3 kg ha-1 + Poultry manure @ 3 t ha-1	109	108	12.4	10.8	97	94	241	239	11.5	9.2	259	251
T7 – 75% STCR + Humic acid @ 20 kg ha-1 + Poultry manure @ 3 t ha-1	178	175	21.3	18.6	148	145	256	251	14.3	11.1	275	271
T8 – 75% STCR + Rhizobium @ 3 kg ha-1 + Humic acid @ 20 kg ha-1 + Poultry manure @ 3 t ha-1	198	193	24.1	21.7	168	164	278	272	16.5	13.2	291	286
T9 - Poultry manure @ 3 t ha-1	93	91	10.4	9.1	73	70	228	222	11.8	10.2	255	251
T10- Absolute control.	66	65	7.5	6.8	56	55	183	178	8.8	8.4	183	177
SEd	10.64	10.52	1.09	1.07	6.62	6.71	9.46	9.33	0.19	0.18	3.34	3.22
CD (P = 0.05)	22.36	22.02	2.30	2.11	13.93	13.45	19.88	19.54	0.41	0.40	7.02	7.01

Similar trend was as that of uptake of nutrients, the available nutrients status after harvest of crop was observed. The two levels of fertilizers with different levels of organic manures significantly influenced the available nutrients (NPK) after harvest of groundnut crop during both the years of study (*Table 3*). The soil available N, P and K were maximum (275, 14.8 and 288 kg ha^{-1}, respectively) in 75% STCR + Rhizobium @ 3 kg ha^{-1} + Humic acid @ 20 kg ha^{-1} + Poultry manure @ 3 t ha^{-1} (T_8) and it was significantly superior to rest of the treatments. This was followed by 75% STCR + Humic acid @ 20 kg ha^{-1} + Poultry manure @ 3 t ha^{-1} (T_7) with the higher available

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N, P and K (253, 12.7 and 273 kg ha^{-1}, respectively). The lower status of available NPK was recorded in fertilizer alone or organic manure alone applied treatments. The absolute control registered lowest status of available N, P and K (180, 8.6 and 180 ka ha^{-1}, respectively). Increase in available N, P and K due to enriched form of organic manure and chemical fertilizers application may be attributed to the direct addition of these nutrients to the available pool of soil. These results are in concordance with the findings of Mahatalea et al. (2023), Satpute et al. (2021) and Mahmood et al. (2017). The rate of release of nutrients from organic manures may depend on initial chemical composition together with the stage of composting. The highest available N, P and K in soil due to combination of fertilizers with organic sources which increased the post-harvest soil by mineralization. Similar findings were reported by Naveen and Senthilkumar (2021), Kumar et al. (2020), Karunakaran et al. (2010) and Ramakrishna et al. (2017).

Economics

The economics (*Table 2*) data reveal that the application of STCR of fertilizer as 38:64:94 kg of NPK ha^{-1} with humic acid @ 20 kg ha^{-1} + rhizobium 3 kg ha^{-1} and poultry manure @ 3 t ha^{-1} (T_8) was the best treatment with net income of ₹ 72,706 ha^{-1} with benefit cost ratio of 2.47 followed by treatment of 75% STCR + Humic acid 20 kg ha^{-1} + Poultry manure @ 3 t ha^{-1} (T_7) with next best net income of (₹ 66,375) with the B:C ratio of 2.35. The poor net income and benefit: cost ratio was obtained from absolute control (T_{10}) (₹ 23,715and 1.53). Due to the poultry manure is a very cheap source compared to all other inputs and it has an high nutrient content. So, it could be increasing the highest net income. The earlier findings of were also supported for this result Satpute et al. (2021), Naveen and Senthilkumar (2021), Akbari et al. (2011) and Gurni and Nath (2012).

Conclusion

It was concluded that in areas where organics are available at cheaper prices, the application of STCR recommended fertilizer as 75% STCR + 3 kg of Rhizobium ha^{-1} + 20 kg of Humic acid ha^{-1} + Poultry manure @ 3 t ha^{-1} (T_8) is effective to maximize the yield and income of groundnut farmers of Alfisols of the Tamiraparani tract.

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