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# Effect of integrated application of organic manures and inorganic fertilizers on nutrient uptake, post-harvest soil available nutrient status and agronomic efficiency of machine sown groundnut

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**Abstract**
A field experiment was conducted in the farmer's field at Arasampalayam village, Rasipuram (Tk.), Namakkal (Dt.), Tamil Nadu during May-Sep, 2021 (Vaigasi Pattam) to study the impact of integrated nutrient management on nutrient uptake, post-harvest soil available nutrient status and agronomic efficiency of machine sown groundnut. The experiment was laid out in a Randomized Block Design (RBD) with three replications. The treatments consisted of $T_0$ – Absolute control (No organics and inorganics), $T_1$ – RDF through inorganic fertilizers (25:50:75 Kg N, $P_2O_5$, $K_2O$ ha$^{-1}$), $T_2$ – 75% RDN + 25% N on equivalent basis of EFYM, $T_3$ – 50% RDN + 50% N on equivalent basis of EFYM, $T_4$ – 75% RDN + 25% N on equivalent basis of poultry manure compost, $T_5$ – 50% RDN + 50% N on equivalent basis of poultry manure compost, $T_6$ – $T_2$ + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg ha$^{-1}$ on 35 and 45 DAS, $T_7$ – $T_3$ + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg ha$^{-1}$ on 35 and 45 DAS, $T_8$ – $T_4$ + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg ha$^{-1}$ on 35 and 45 DAS, $T_9$ – $T_5$ + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg ha$^{-1}$ on 35 and 45 DAS. The results of this experiment showed that combined application of 75% RDN + 25% N on equivalent basis of poultry manure compost + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg ha$^{-1}$ on 35 and 45 DAS recorded highest nutrient uptake, post-harvest soil available nutrient status and agronomic efficiency recorded with significantly higher values.

**Keywords:** Integrated, EFYM, Poultry manure compost, Salicylic acid, TNAU groundnut rich, RDN

## Introduction
Groundnut (*Arachis hypogaea* L.) is one of the most important leguminous edible oilseed and cash crop and is a valuable source of all the nutrients (48 to 50% of oil, 26 to 28% protein, 20% carbohydrates and 5% fibre). Groundnut or Peanut is known as "King of Oilseeds", which belongs to Legume family (Fabaceae). Groundnut is also called as Earthnuts, Monkey nuts, Wonder nut and Poor man's cashew nut. It is widely cultivated as rainfed as well as irrigated crop and plays a key role in livelihood of millions of people in the world. Groundnut is also valued as a rotation crop. Being a legume with a root nodule it can synthesis atmospheric nitrogen and thereby improve soil fertility. It is an important multipurpose crop for resource less poor farmers in the semi - arid tropics (Shwetha *et al*., 2018) [14].

Globally, groundnut is cultivated over an area of 30.00 million hectares with a production of 50.25 million metric tonnes and productivity of 1.67 metric tonnes ha$^{-1}$ annually. India ranks first in the world's groundnut area (6.02 m. ha), production (6.70 million metric tonnes) and with the productivity (1.11 t ha$^{-1}$) during 2020 - 2021 (USDA, 2022) [15]. In India, the groundnut production is mostly concentrated in Gujarat, Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra and Rajasthan. In Tamil Nādu, groundnut is cultivated with an area of 4.09 lakh ha, production of 10.23 lakh tonnes and productivity of 2502 kg ha$^{-1}$ during 2020 – 2021 (Indiastat, 2022) [8].

The average yield of groundnut in India is extremely low due to cultivation of groundnut mainly under rainfed conditions, biotic and abiotic stresses and many socio-economic factors. Imbalanced and inadequate use of nutrients is one of the major constraints for lower yield of groundnut.

On contrary, groundnut farmers of most part of the semi-arid region use very less nutrient fertilizer resulting in severe mineral deficiencies due to inadequate and imbalance use of nutrients is one of the major factors responsible for low yield in groundnut. Proper fertilizer management of groundnut crop with right kind of nutrients at correct time adapting right method of application improve the production and soil fertility status. An integrated approach to plant nutrient management has gained momentum and has become more essential due to the escalating production cost of mineral fertilizers. The residual toxicities of these inorganic fertilizers posing problem of environmental pollution, the depletion of essential nutrients due to indiscriminate use of inorganic fertilizers which has a threat to the sustainability of crop production. For Sustained groundnut production the modern farming demand efficient and balanced fertilizer use through conjunctive use of organic, inorganic, biofertilizers and crop residues.

The combined use of organic and inorganic source of plant nutrients not only pushed the production and profitability of field crops, but also helped in improving the fertility status of the soil (Kannan *et al*., 2013) [10]. Nitrogen (N) is the most important mineral nutrient which affects the growth and yield of crops. Nitrogen often limits the primary production in agricultural and natural ecosystems (De vries *et al.,* 2006) [3] therefore, its availability in adequate amount in plant available form is important for higher crop yields. Knowledge about its judicious application in optimum amounts and at times synchronous with its peak demand is imperative to achieve higher N use efficiency. To maintain the long-term sustainability of agriculture, effective and efficient approaches to slow the removal and returning nutrients into the soil is required. The overall strategy for increasing crop yields and sustaining them at a high level must, therefore, include an integrated approach to the management of soil nutrients, along with other complementary measures. In this case, the availability and utilization of the yield-limiting essential nutrients particularly N use efficiency will be improved. The combined application of organic manure and N fertilizer maintains a continuous N supply, prevents losses and thus helps in more efficient utilization of the applied nitrogen (Dwivedi *et al*., 2016) [4]

Foliar feeding is a very effective and economical way to correct plant nutrient deficiencies and enhance the yield. Foliar nutrition could help to maintain a nutrient balance within the plant, which might not occur strictly with soil uptake (Meena *et al*., 2007) [11]. Foliar feeding targeted the growth stages where declining rates of photosynthesis occured and enhanced the root growth and nutrient absorption (Gunasekar *et al*., 2018) [6]. The effectiveness of foliar applied nutrients is determined by the type of formulation and the time of application. Foliar spray stimulated an increase in chlorophyll production, cellular activity and respiration. It also triggered a plant response to increased water and nutrient uptake from the soil (Veeramani *et al*., 2012) [16]. Foliar application of salicylic acid and TNAU groundnut rich increases flowering, speed up photosynthesis, arrest flower drop and supplement the required micronutrients at a faster rate. Hence, an effort has been made to increase the groundnut yield by combining foliar application of nutrients along with recommended dose of fertilizers.

## Materials and Methods

The field experiment for this study was conducted at the farmer's field at Arasampalayam village in Rasipuram taluk of Namakkal district, Tamil Nadu during Vaigasi Pattam (May – Sep), 2021. Geographically the field is situated at 11.44º N latitude, 78.08º E longitude with an altitude of +132.67 meters above mean sea level. The average annual rainfall of this study area is 640 mm. The entire cropping period received the rainfall of 118 mm distributed over 22 rainy days. The maximum temperature during cropping period ranged from 31º to 37 ºC, while the minimum temperature ranged from 23º to 28 ºC with a mean of 25.5 ºC and the relative humidity ranged from 48 to 70%.

The soil of the experimental field was sandy loam in texture with a pH of 8.4. The soil was low in available nitrogen (198.50), high in available phosphorus (24.75) and high in available potassium (348.20). The predominantly grown groundnut variety (TNAU Co 6) of this region was chosen for the study for its suitability and yield potentiality. The seeds were dibbled by using tractor drawn seed drill to maintain optimum plant population. The experiment was laid out in a Randomized Block Design (RBD) with three replications. The treatments consisted of $T_0$ – Absolute control (No organics and inorganics), $T_1$ – RDF through inorganic fertilizers (25:50:75 Kg N, $P_2O_5$, $K_2O$ $ha^{-1}$), $T_2$ – 75% RDN + 25% N on equivalent basis of EFYM, $T_3$ – 50% RDN + 50% N on equivalent basis of EFYM, $T_4$ – 75% RDN + 25% N on equivalent basis of poultry manure compost, $T_5$ – 50% RDN + 50% N on equivalent basis of poultry manure compost, $T_6$ – $T_2$ + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg $ha^{-1}$ on 35 and 45 DAS, $T_7$ – $T_3$ + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg $ha^{-1}$ on 35 and 45 DAS, $T_8$ – $T_4$ + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg $ha^{-1}$ on 35 and 45 DAS, $T_9$ – $T_5$ + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg $ha^{-1}$ on 35 and 45 DAS.

The recommended dose of 25:50:75 kgs of NPK $ha^{-1}$ in the form of urea (46% N), single super phosphate (16% $P_2O_5$) and muriate of potash (60% $K_2O$) were applied on machine sown groundnut crop. 50% N, 100% $P_2O_5$ and 50% $K_2O$ were applied as basal dose. The remaining 50% N and 50% $K_2O$ were top dressed in two equal splits on 20 DAS and 45 DAS. The recommended dose of $P_2O_5$ and $K_2O$ was applied to all the treatments except absolute control. The treatments with different doses of N were applied as per treatment schedule. Besides, the enriched farm yard manure and poultry manure compost was applied well before the sowing of groundnut as per the treatments. Quantity of EFYM, poultry manure compost to be added to each treatment was calculated on the basis of N content in EFYM and poultry manure compost. The remaining recommended dose of N was supplied through inorganic fertilizers. Gypsum @ 80 kg S on 45 DAS, foliar application of salicylic acid @ 100 ppm and TNAU groundnut rich @ 5.0 kg $ha^{-1}$ on 35 and 45 DAS were applied as per treatment schedule.

Irrigation was given immediately after sowing with good quality water with due care to avoid excess soaking of seeds. The life irrigation was given on 3 DAS. The subsequent irrigation was given to the crop as and when required. The standard crop management practices were followed during the

cropping period. The powdered plant material was used for the nutrient uptake studies. Composite soil samples collected from the experimental field before laying out the field experiment and after the harvest of the crop were used for analysis of post-harvest soil available nutrient status. The estimated data were analyzed as per the procedure outlined by Gomez and Gomez (1994) [5]. The critical difference was worked out at 5% probability level for significant results.

**Assessing nitrogen efficiency**

**Agronomic efficiency (AE)**

Agronomic efficiency is defined as the quantity of grain yield obtained from fertilized plot and unfertilized plot to $kg^{-1}$ of nitrogen applied. It was computed using the formula

$$AE = \frac{G_f - G_u}{Na}$$

Where,

$G_f$ - Grain yield in fertilized plot (kg $ha^{-1}$)

$G_u$ - Grain yield in unfertilized plot (kg $ha^{-1}$)

Na - Quantity of fertilizer N applied (kg $ha^{-1}$)

**Results and Discussion**

**Nutrient uptake**

The nutrient uptake data revealed that the nutrient uptake of the groundnut exhibited significant variation due to the integrated nutrient supply system. Among the different treatments, the integrated application of 75% RDN + 25% N on equivalent basis of poultry manure compost + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg $ha^{-1}$ on 35 and 45 DAS was significantly recorded the maximum uptake of N (102.98 kg $ha^{-1}$), P (18.60 kg $ha^{-1}$) and K (89.54 kg $ha^{-1}$) respectively. It was followed by the treatment $T_6$ - 75% RDN + 25% N on equivalent basis of EFYM + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg $ha^{-1}$ on 35 and 45 DAS. However, $T_9$ - $T_5$ + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg $ha^{-1}$ on 35 and 45 DAS and $T_7$ - $T_3$ + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg $ha^{-1}$ on 35 and 45 DAS were next in order and found to be on par with each other at both the stages of crop growth. This was followed by $T_1$, $T_4$, $T_2$, $T_5$ s and $T_3$. Whereas, the absolute control ($T_0$) had the least effect in all other treatments.

The uptake of nutrients was increased with the application of poultry manure compost might be due to enhanced supply of plant nutrients by direct addition through nitrogen fixation and solubilisation of native phosphorus content of soil and also by increasing nutrient use efficiency and better absorption and utilization of nutrient in balanced form (Choudhary *et al*., 2011) [2]. Another factor contributing to more nutrient uptake with poultry manure compost might be due to presence of high phosphorus content and increased availability of native soil phosphorus. The results are similar with the findings of Bulu *et al*. (2016) [1] in groundnut production in which they reported that organic manure, especially poultry manure could increase yield of crops when compared with other sources of manure.

The positive impact of nutrient uptake seed and haulm seems to be on account of better development of canopy which might have maintained adequate supply of metabolites for better growth. Thus better developed root system might have facilitated in more extraction of nutrients from soil and translocated to plant parts under foliar application of Salicylic acid and TNAU groundnut rich in groundnut. These findings are in similar with Nafees *et al*. (2010) [12].

**Post-harvest soil available nutrient status**

Integrated application of 75% RDN + 25% N on equivalent basis of poultry manure compost + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg $ha^{-1}$ on 35 and 45 DAS ($T_8$) recorded higher post-harvest soil available N (215.38 kg $ha^{-1}$), P (24.96 kg $ha^{-1}$) and K (354.86 kg $ha^{-1}$). This might be due to improvement in soil through physical, chemical and biological condition and which might have resulted in more available nutrients from native source. Addition of chemical fertilizer along with organic manure narrowed the C:N ratio of organic manure and this enhanced the mineralization and resulting in rapid release of nutrients. These findings are in similar with Jacob *et al*. (2014) [9].

Application of NPK and poultry manure compost increased the nutrient uptake and post-harvest soil nutrient availability in residual crop. This may be due to the slow mineralization and availability of nutrients to the residual crop. The improvement and maintenance of chemical fertility of soil due to integration with inorganic fertilizers might be due the gradual mineralization of organics and chelation of nutrients and solubilization of nutrients from native source, thereby lowering the loss of nutrients from root zone by fixation, precipitation, Volatilization or leaching. These findings are in similar with Patel *et al.* (2007) [13].

**Agronomic efficiency of N**

Among the treatments, the combined application of 75% RDN + 25% N on equivalent basis of poultry manure compost + foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg $ha^{-1}$ on 35 and 45 DAS ($T_8$) recorded higher agronomic efficiency of 50.41. This might be due to increased availability of nitrogen in Poultry manure compost in the form of mucous, nitrogenous excretory substances which were not present in other organic sources like EFYM. Nitrogen fixing bacteria were also found to be more in this poultry which might have reduced the loss of nitrogen from the soil and increased the use efficiency of inorganic fertilizers applied. These findings are in similar with Ihseen *et al*. (2003) [7].

**Table 1:** Effect of integrated nutrient management on nutrient uptake (kg ha$^{-1}$), Post-harvest soil available nutrients (kg ha$^{-1}$) and agronomic efficiency of machine sown groundnut.

| Treatments | Nutrient uptake by crop | | | Post-harvest soil available nutrients (kg ha$^{-1}$) | | | Agronomic efficiency |
|---|---|---|---|---|---|---|---|
| | N uptake (kg ha$^{-1}$) | $P_2O_5$ uptake (kg ha$^{-1}$) | $K_2O$ uptake (kg ha$^{-1}$) | N | P | K | |
| $T_0$ – Absolute control (No organics and inorganics) | 52.38 | 9.18 | 45.12 | 158.27 | 17.90 | 271.30 | - |
| $T_1$ – RDF through inorganic fertilizers (25:50:75 kg N, $P_2O_5$, $K_2O$ ha$^{-1}$) | 79.91 | 14.48 | 69.49 | 196.15 | 23.17 | 313.44 | 27.00 |
| $T_2$ – 75% RDN + 25% N on equivalent basis of EFYM | 70.15 | 12.71 | 61.00 | 189.98 | 22.48 | 299.14 | 18.00 |
| $T_3$ – 50% RDN + 50% N on equivalent basis of EFYM | 61.14 | 11.08 | 53.17 | 184.67 | 21.72 | 284.72 | 08.45 |
| $T_4$ – 75% RDN + 25% N on equivalent basis of poultry manure compost | 72.73 | 13.18 | 63.25 | 191.02 | 22.61 | 300.59 | 20.52 |
| $T_5$ – 50% RDN + 50% N on equivalent basis of poultry manure compost | 63.02 | 11.42 | 54.80 | 185.56 | 21.87 | 286.56 | 11.16 |
| $T_6$ – $T_2$ + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg ha$^{-1}$ on 35 and 45 DAS | 95.99 | 17.39 | 83.47 | 209.54 | 24.46 | 341.06 | 43.64 |
| $T_7$ – $T_3$ + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg ha$^{-1}$ on 35 and 45 DAS | 87.11 | 15.78 | 75.75 | 202.76 | 23.81 | 326.89 | 34.20 |
| $T_8$ – $T_4$ + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg ha$^{-1}$ on 35 and 45 DAS | 102.98 | 18.60 | 89.54 | 215.38 | 24.96 | 354.86 | 50.41 |
| $T_9$ – $T_5$ + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg ha$^{-1}$ on 35 and 45 DAS | 89.03 | 16.13 | 77.42 | 204.83 | 23.93 | 328.10 | 37.12 |
| S.Em± | 1.32 | 0.17 | 0.96 | 1.34 | 0.15 | 3.80 | (Data statistically not analyzed) |
| CD (P= 0.05) | 3.97 | 0.51 | 2.89 | 4.04 | 0.47 | 11.40 | |

RDN* - Recommended dose of nitrogen
RDF* - Recommended dose of fertilizers
EFYM* - Enriched farmyard manure
DAS*- Days after sowing

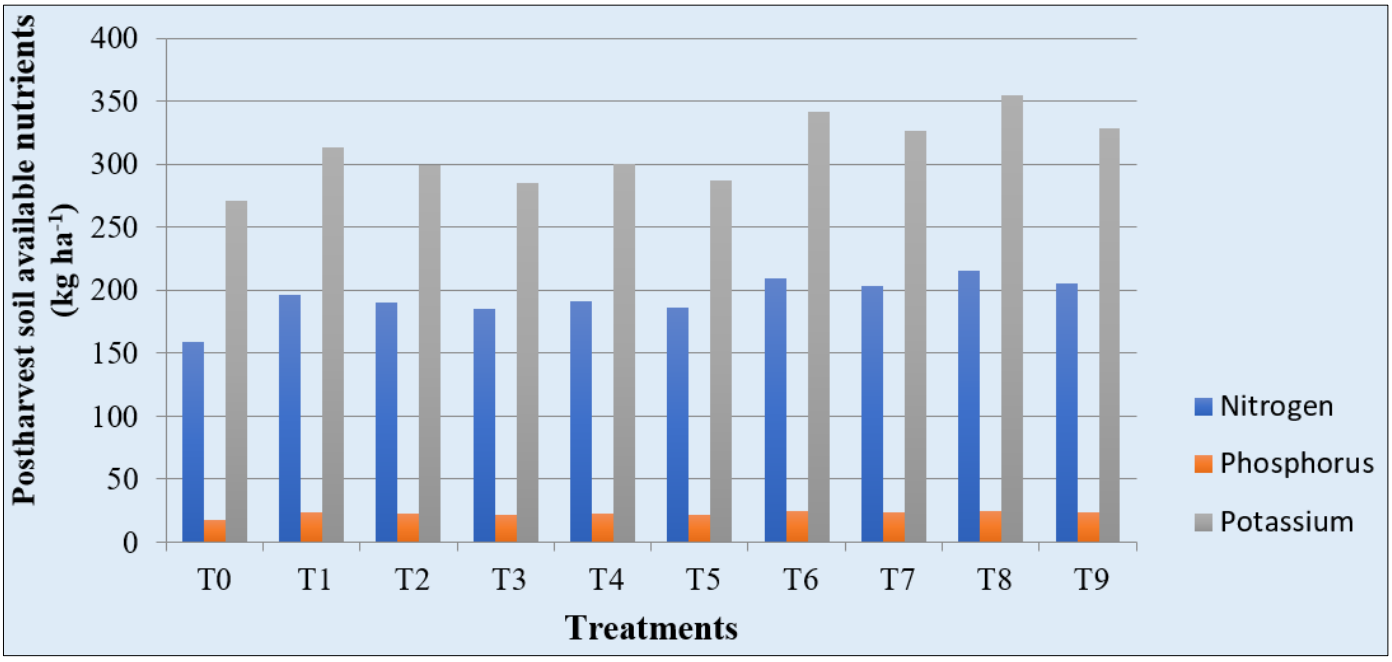


**Fig 1:** Effect of integrated nutrient management on post-harvest soil available nutrients (kg ha$^{-1}$) of machine sown groundnut

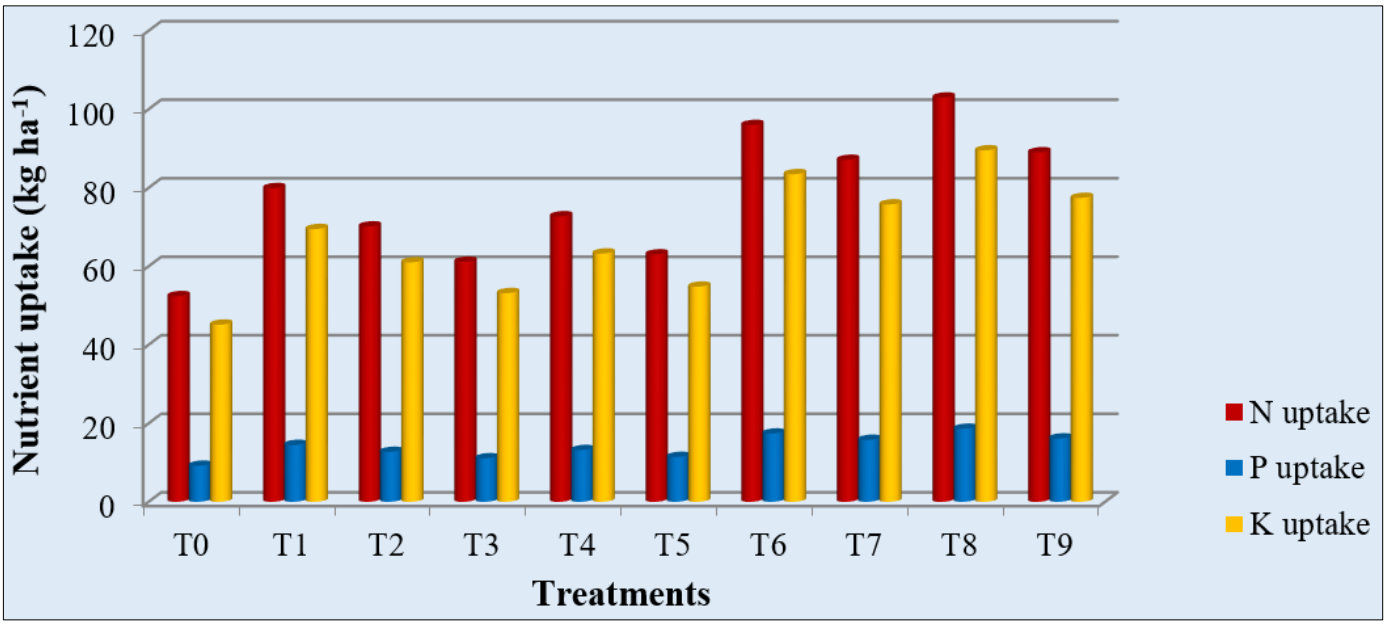


**Fig 2:** Effect of integrated nutrient management on nutrient uptake (kg $ha^{-1}$) by machine sown groundnut

## Conclusion

The combined application of organic manures and inorganic fertilizers improves soil fertility status and leads to sustainable soil fertility management. The present investigation concluded that integrated application of 75% RDN + 25% N on equivalent basis of poultry manure compost + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg $ha^{-1}$ on 35 and 45 DAS registered the maximum nutrient uptake (N, P and K), post-harvest soil available nutrient status and agronomic efficiency of N.

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