EFFECT OF DIFFERENT NUTRIENT MANAGEMENT APPROACHES ON SOIL INORGANIC NITROGEN FRACTIONS IN GROUNDNUT AND THERE CORRELATION WITH YIELD

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Abstract - A field experiment was conducted during kharif (2021) season to study soil nitrogen fractions in groundnut under different nutrient management approaches in the central dry zone of Karnataka, using groundnut variety TMV-2 as test crop at Zonal Agriculture and Horticulture Research Station (ZAHRS), Hiriyur. The experiment was laid out in RCBD design with four treatments, five replications in an area of 20mx10m size of experimental plot. This experiment comprises the treatments viz., Organic farming - Seed treatment with Rhizobium and PSB + Recommended dose of FYM (10 t ha-1) + P equivalent basis of FYM; Natural farming - Seed treatment with beejamrutha + ghanajeevamrutha @ 1000 kg ha-1 before sowing + jeevamrutha @ 500 L ha-1 @ 30 days interval + mulching; POP (package of practice) - Seed treatment with Rhizobium and PSB + Recommended dose of FYM (10 t ha-1) + 25:75:37.5 kg ha-1 NPK + ZnSO4 @ 10 kg ha-1 + Borax @ 10 kg ha-1 + Gypsum @ 500 kg ha-1; Farmer's practice - 40:20:30 kg ha-1 NPK. The data after harvest of the groundnut revealed that soil properties like bulk density, pH, EC did not vary significantly. Organic carbon was recorded highest in organic farming, natural farming. Available macronutrients and secondary nutrients like nitrogen, phosphorus, potassium, exchangeable calcium and magnesium and sulphur were observed highest in POP. Dehydrogenase, phosphatase and urease activity was recorded significantly higher in organic farming. Nitrogen fractions like total nitrogen was recorded highest in organic farming. Available nitrogen, NH4+-N and NO3- -N were initially higher for farmer's practice but at later growth stages, it was higher for POP. Total nitrogen, available nitrogen, NH4+-N and NO3- -N were positively correlated with yield.

I. INTRODUCTION

Nitrogen is one of the important primary nutrient element and essentially required for crop growth and development. It has been observed that nitrogen is most frequently deficient nutrient in crop production. Therefore understanding the behaviour of nitrogen in the soil is essential for maximizing agricultural production and profitability, while reducing the impact of nitrogen fertilization on the environment. Many nitrogen sources are available for use in supplying nitrogen to growing crops. In addition to inorganic fertilizer nitrogen, organic nitrogen from animal manures and other waste products and from nitrogen fixing leguminous crops can supply sufficient nitrogen for crop production. The impact of modern agriculture on natural resources has become a major global concern. Population growth and expanding demand for agricultural products constantly increase the pressure on land and water resources. A major point of concern for many intensively managed agricultural systems with high external inputs is the low resource-use efficiency, especially for nitrogen. A high input combined with a low efficiency ultimately results in environmental problems such as soil degradation, eutrophication, pollution of groundwater, emission of ammonia and greenhouse gases. Evidently, there is a need for a transition of current agricultural systems into highly resource-use efficient systems that are profitable, but at the same time ecologically safe and socially acceptable. [48]

India is one of the major oilseeds grower and importer of edible oils. India's vegetable oil economy is world's fourth largest after USA, China & Brazil. The oilseed accounts for 13 percent of the Gross Cropped Area, 3 percent of the Gross National Product and 10 percent value of all agricultural commodities. This sector has recorded annual growth rate of area, production and yield @ 2.44 percent, 5.47 percent and 2.96 percent respectively during last decade (1999-2009).

The diverse agro-ecological conditions in the country are favorable for growing 9 annual oilseed crops, which include seven edible oilseeds viz., groundnut, rapeseed & mustard, soybean, sunflower, sesame, safflower and niger and two non-edible oilseeds viz., castor and linseed. Oilseeds cultivation is undertaken across the country in about 27 million hectares mainly on marginal lands, of which 72 percent is confined to rainfed farming cultivation system.

Groundnut (Arachis hypogaea), is a specie in the legume family (Fabaceae) native to South America, Mexico and Central America. It is an annual herbaceous plant growing to 30 to 50 cm tall. Groundnut is an important oil seed crop in India with 5.86 m ha and 8.26 m tonnes production. Though groundnut is primarily used as oil seed crop, some of

the groundnut varieties are recommended as table purpose for direct consumption because of its high food value.

Organic farming is a production system which largely excludes or avoids the use of fertilizers, pesticides, growth regulators, preservatives, livestock feed additives and totally rely on crop residues, animal manures, legumes, green manures, off-farm wastes, mechanical cultivation, mineral nutrient bearing rocks and biological pest control to maintain soil health, supply plant nutrients and minimize insects, weeds and other pests.

Natural Farming (or ZBNF) involves the application of Jeevamritha, Beejamritha, mixed cropping system, home-made preparations for plant protection and seed/planting materials, and mulching. Thus, it envisages complete freedom from chemicals from farming. Using at least Jeevamritha and not using any chemicals (fertilizers/pesticides/growth promoters). Both the conditions together were considered essential for terming as NF-adopter farmers.

Integrated nutrient management (INM) is an approach that seeks to increase production quality and protect the environment for posterity. It relies on nutrient application and conservation, new technologies to increase nutrient availability to plants, and the dissemination of knowledge between farmers and researchers (Palm et al., 2001). In the past, nutrient management was driven by the need to maximize production. However, sustainable nutrient management involves maximizing production, preventing on-site soil degradation, and minimizing off-site involvement of applied nutrients. [55] Given the above facts, the present study entitled " effect of different nutrient management approaches on soil inorganic nitrogen fractions in groundnut and there correlation with yield." was undertaken to know the best nutrient approach.

II. MATERIALS AND METHODS

Experimental site

The experiment was conducted at ZAHRS, Babbur farm, Hiriyur, situated in Central Dry Zone (Agro-Climatic Region IV) of Karnataka. The geographical reference point of the experimental site was 130 57' North latitude and 750 38' East longitude, with an altitude of 606 meters above mean sea level (MSL).
The soil has clay loam texture and black in color. The analysis data indicated that soil was moderately alkaline in reaction with a normal electrical conductivity and low in organic carbon. Further, soil was low in available nitrogen status, medium status for available phosphorus and high in available potassium.
Field experiments was conducted in black soil of ZAHRS, Babbur Farm, Hiriyur, using groundnut (variety-TMV-2) as test crop with four treatments replicated five times. The experiment was laid out in randomized complete block design, spacing 30*10cm and size of the plot is 20m*10m.

Treatment details:

T1- Organic farming - Seed treatment with Rhizobium and PSB + Recommended dose of FYM (10 t ha-1) + P equivalent basis of FYM
T2 - Natural farming - Seed treatment with Beejamrutha + Ghanajeevamrutha @ 1000 kg ha-1 before sowing + Jeevamrutha @ 500 L ha-1 @ 30 days interval + mulching
T3 -POP - Seed treatment with Rhizobium and PSB + Recommended dose of FYM (10 t ha-1) + 25:75:37.5 kg ha-1 NPK + ZnSO4 @ 10 kg ha-1 + Borax @ 10 kg ha-1 + Gypsum @ 500 kg ha-1
T4- Farmer's practice - 40:20:30 kg ha-1 N, P2O5, K2O
Note: Organic amendments like FYM, Beejamrutha, Ghanajeevamrutha and Jeevamrutha was characterized for total elemental composition before application

Soil sampling and analysis

The treatment wise composite soil samples from each replication at harvest of crop were collected from of 0-15 cm depth at initial, 30, 60, 90 DAS and at harvest which were used for
different chemical parameters analysis. The initial and at harvest samples were analyzed for different physical, chemical and biological properties and nitrogen fractions like exchangeable ammonical nitrogen, nitrate nitrogen, available nitrogen and total nitrogen. Samples collected at above mentioned intervals were analyzed for nitrogen fraction. Soil samples collected were shade-dried and passed through 2 mm sieve before analysis. Bulk density was determined by Keen's cup method.[36] Soil pH was measured by potentiometric method using glass electrode.[19] The electrical conductivity (EC) of soil was determined in 1:2.5 soil : water suspension using Conductivity Bridge and the results were expressed in dSm-1. [19] Soil organic carbon was determined by using Walkley and Black's wet oxidation method (1934).[64] Available nitrogen was determined by alkaline potassium permanganate method.[52]For analyzing ammonical nitrogen and nitrate nitrogen, soil samples were leached with 25 ml of 2M KCl solution, followed by adding 0.5 g of MgO powder for estimating NH4+-N and NaOH was used, while estimating NO3--N by modifying Kjeldahl method.[25]Total nitrogen was determined by using CHNS elementar analyzer (Vario EL CUBE model). Semi-macro analysis for CHNS is 40 mg of soil sample. Available phosphorus in soil was extracted by Olsen's extractant (0.5 M NaHCO3) and the content of phosphorus was determined by ascorbic acid blue colour method at 660 nm. [19] Available potassium was determined by using flame

photometer. [19] Sulphate sulphur in the soil was extracted by using 0.15 per cent calcium chloride solution. [19] Extraction of soil with 1N (pH 7) ammonium acetate followed by complexometric titration for estimation of exchangeable calcium and magnesium.[4] The dehydrogenase enzyme was analyzed following the procedure described by Casida et al. (1964).[9] The phosphatase enzyme activity was analyzed following the procedure outlined by Eivazi and Tabatabai (1977). [14] The urease enzyme activity was analyzed following the procedure outlined by Tabatabai and Bremner (1972).[54]

The major nutrients such as nitrogen, phosphorus and potassium present in beejamrutha, jeevamrutha, ghanajeevamrutha were estimated by following microkjeldhal, vanadomolybdate and flame photometric methods respectively. Micronutrients present in beejamrutha were estimated using Atomic Absorption Spectrophotometer (AAS). Chemical composition of ghanajeevamrutha is presented in Table 2.

Statistical analysis and interpretation of data

The experimental data obtained were subjected to statistical analysis using Fisher's method of analysis of variance.[16] Correlation analysis was carried out to assess the relationship among different soil nitrogen fractions and yield by Pearson correlation coefficient using SPSS statistics.

III. RESULTS AND DISCUSSION

Soil physical, physico-chemical and biological properties after harvest of the groundnut as influenced under different nutrient management approaches

The bulk density of soil was statistically non-significant among the treatments after harvest of the crop. Bulk density of soil samples ranged from 1.09-1.13 Mg m-3. However, numerically lowest value of bulk density was observed in organic farming over other treatments. The highest value of bulk density was observed in farmer's practice. The findings of Kapoor et al. (2015), Bhatt et al. (2019) and Kumar et al. (2011) reported that the application of organic matter decreased the bulk density of soil and significantly increased the synthesis of polysaccharides and microbial gum, which served as a binding agent for soil particles (Table 3).

The outcomes showed that pH of the soil was statistically non-significant among the treatments after harvest of the crop. The pH value observed in, organic farming (8.35) was numerically lower than other treatments. Highest pH value was observed in farmer's practice (FP) with the value of 8.51. The soluble salt content was found statistically non-significant among different treatments after harvest of the crop. However, EC value observed in organic farming (0.52 dS m^{-1}) was numerically higher over other treatments. Least EC was recorded in farmer's practice (0.48 dS m^{-1}) after harvest. The generation of organic acids during the breakdown and mineralization of organic manures may be the cause of the small reduction in pH and EC with the application of organic sources. Similar findings were made by Singh et al. (1980), who observed that pH fell by one unit as a result of applying 7 tons of FYM during a four-year period. Due to the application of organic manure, Badanur et al. (1990) saw a considerable decrease in soil reactivity comparable to the application of fertilizer (Table 3).

The value of organic carbon among treatments ranged from 4.4-4.8 g kg^{-1}. The highest value of organic carbon was observed in organic farming (4.8 g kg^{-1}) and natural farming (4.8 g kg^{-1}), which was statistically on par with POP (4.7 g kg^{-1}). Significantly lower value of organic

carbon was observed in farmer's practice (4.4 g kg^{-1}). These findings are in consistence with findings of Kaushik et al. (1984), Kowaljow and Mazzarino (2007) and Chivenge et al. (2009) who found that organic amendments increased soil organic carbon. After four years of the decomposition of organic manure over fertilizer treatment, Bellakki and Badanur (1994) saw a considerable rise in the organic carbon content of Vertisol (Table 3).

Among different treatments, significantly higher value of available nitrogen was recorded in POP (339.36 kg ha-1), followed by farmer's practice (323.42 kg ha^{-1}) and organic farming (305.58 kg ha^{-1}). Significantly lower value of available nitrogen was recorded in natural farming (279.68 kg ha^{-1}). The higher soil microbial proliferation brought on by the addition of organic materials, which mineralize organically bound N to inorganic form, is also responsible for the increase in accessible nitrogen as a result of the application of organic matter (Bellakki and Badanur, 1997). These results were in tandem with the findings of Adjei-Nsiah (2012), Singh and Kumawat (2008) and Yang Rong et al. (2016) (Table 4 and figure 1).

POP (29.88 kg ha-1) recorded significantly higher value of phosphorus, which was statistically on par with farmer's practice (29.08 kg ha^{-1}), followed by organic farming (28.15 kg ha^{-1}). In natural farming (26.79 kg ha-1), the available phosphorus value was found to be significantly lower. The value of available phosphorus is 11.5 percent higher in POP than natural farming. It is consistent with the findings of Singh et al. (1982), who observed an increase in the amount of soil-available phosphorus following the incorporation of FYM alone or in combination with

inorganic fertilizers and attributed it to improved phosphorus solubilization by the by product of organic manures' decomposition. Further, these results agree with those of Tandon (1987), Guo and Sims (2002), Tognetti et al. (2008) and Khokle (2016) (Table 4 and figure 1).

Among four treatments, application of recommended dose of fertilizer with FYM (347.82 kg ha^{-1}) recorded significantly higher concentration of available potassium in soil, followed by farmer's practice (346.70 kg ha^{-1}), which was statistically on par with organic farming (346.25 kg ha^{-1}). Lowest concentration of potassium was observed on natural farming (345.41 kg $ha^{-1)}$. According to Shri Ram et al. (2016), continuous inorganic fertilizer treatment, FYM, and cropping over 41 years considerably raised the available K content. The plots treated with FYM also had the highest levels of available K, which were followed by super-optimal doses of NPK fertilizers. Similar findings were also reported by Kaur and Benipal (2006), Ebid et al. (2007) and Paradelo et al. (2012) (Table 4 and figure 1).

Among various treatments, POP (package of practices) recorded the maximum exchangeable magnesium (15.53 cmol (p+) kg^{-1}), followed by natural farming (14.39 cmol (p+) kg^{-1}) and organic farming (13.53 cmol (p+) kg-1). Significantly lower value of exchangeable magnesium was observed in farmer's practice (10.60 cmol (p+) kg^{-1}). The significantly higher value of exchangeable calcium after harvest of the crop was recorded in POP (34.97 cmol (p+) kg^{-1}), followed by natural farming (34.35 cmol p(+) kg^{-1}) and organic farming (33.96 cmol (p+) kg^{-1}). The significantly lower value of exchangeable calcium was observed in farmer's practice (30.95 cmol (p+) kg^{-1}). The value of exchangeable calcium and magnesium significantly decreased in farmer's practice. Higher availability of calcium in POP may be attributed to the application of gypsum. Further application of organic residues increased the cation exchange capacity of the soil. Improved cation exchange capacity is important since it leads to increased availability of plant nutrients and hence improves the fertility status of the soil. Organic anions released from FYM retard the phosphorus fixation in soil by complexing with organic ligands and chelation of it with cations like Ca, Mg, Fe, Al, Zn, Mn and Cu. Similar findings were reported by Thirunavukkarasu and Balaji (2015), Ramakrishna et al. (2016) and Gogoi et al. (2012) (Table 5 and figure 2).

Among four treatments, the significantly higher value of sulphur was recorded in POP (35.86 mg kg^{-1}), followed by organic farming (34.93 mg kg^{-1}) and natural farming (32.80 mg kg^{-1}). The significantly lower value of available sulphur was recorded in farmer's practice (30.95 mg kg^{-1}). According to Vadiraj et al. (1992), the release of organically bound sulphur during mineralization is what caused the increase in available S content. The increase in accessible sulphur in such soils was probably caused by the addition of larger amounts of organic manures and a longer duration of organic farming. The findings of Swarup and Ghosh (1980), who observed greater SO4-S content in the soils with usage of FYM are supported by the data (Table 5 and figure 3).

Among four treatments significantly higher dehydrogenase activity was observed in organic farming (97.38 µg TPF g-1 soil day^{-1}), followed by POP (95.66 µg TPF g^{-1} soil day-1), and natural farming (93.06 µg TPF g-1 soil day-1). Significantly lower dehydrogenase activity was observed in farmer's practice (64.04 µg TPF g-1 soil day-1) at harvest of the crop.

Dehydrogenase activity in organic farming (T1) and POP (T3) was 4.6 percent and 2.8 percent higher than natural farming. Dehydrogenase activity may be higher in organic farming due to the direct addition of organic matter through farmyard manure and an increase in root biomass, both of which aided in the growth and development of soil microorganisms and had a favorable impact on dehydrogenase activity compared to control (Meshram et al. 2016).The outcomes support the conclusions reached by Krishnakumar et al. (2005) and Katkar et al. (2012) (Table 6 and figure 4).

Among four treatments, the significantly higher phosphatase activity was observed in organic farming (22.46 µg PNP g-1 h^{-1}), which was statistically on par with POP (21.72 µg PNP g-1 h^{-1}) followed by natural farming (19.20 µg PNP g-1 $h^{-1)}$. The significantly lower value of phosphatase activity was recorded in farmer's practice (7.76 µg PNP g-1 h^{-1}). Phosphatase activity in organic farming (T1) and POP (T3) was 16.9 percent and 13.1 percent higher than natural farming (T2). Alkaline phosphatase activity increased, which showed that organic matter considerably raised soil enzyme activity. The addition of organic materials to the soil acted as a carbon source that increased microbial biomass and phosphatase activity, demonstrating that these enzymes are of microbial origin. The crop growth stage also significantly influenced the soil enzyme activities, according to Sriramchandrasekhran and Ravichandran (2011). Bohem et al. (2005) and Sheng et al. (2005) reported similar outcomes as well (Table 6 and figure 5).

Among four treatments, the highest urease activity was observed in organic farming (41.69 NH4+-N g-1 soil 2h-1), followed by POP (40.58 NH4+-N g-1 soil 2h-1) and natural farming (38.54 NH4+-N g-1soil 2h-1). The significantly lower value of urease activity was recorded in farmer's practice (19.40 NH4+-N g-1 soil 2h-1). The increase in activity of urease enzyme in organic farming maybe due to application of FYM.

Further, the activity of urease enzyme directly depends upon total nitrogen in soil. The impact of organic fertilizers, especially organic-mineral fertilizers, on soil enzyme activity is typically greater than that of mineral fertilizers. Combined usage of organic manures boosted the enzyme activity of the soil rather than single organic manure application (Krishnakumar et al. 2005). Enzyme activities were increased in long-term manured soils compared to unmanured soils (Goyal et al. 1993) (Table 6 and figure 6).

Nitrogen fractions in soil at 30. 60, 90 DAS and after harvest of groundnut as influenced under different nutrient management approaches.

Total nitrogen (mg kg-1)

Among four treatments, the significantly higher concentration of total nitrogen at 30 DAS was observed in organic farming (805.93 mg kg-1), followed by POP (795.91 mg kg-1) and natural farming (784.79 mg kg-1). The significantly lower value of total nitrogen was recorded in farmer's practice (775.82 mg kg-1). Among four treatments, the significantly higher concentration of total nitrogen at 60 DAS was observed in organic farming (811.17 mg kg-1), followed by POP (800.90 mg kg-1) and natural farming (791.14 mg kg-1). The significantly lower value of total nitrogen was recorded in farmer's practice (782.62 mg kg-1). Among four treatments, the significantly higher concentration of total nitrogen at 90 DAS was observed in organic farming (825.97 mg kg-1), followed by POP (820.79 mg kg-1) and natural farming (808.77 mg kg-1). The significantly lower value of total nitrogen was recorded in farmer's practice (791.11 mg kg-1). Among four treatments, the significantly higher concentration of total nitrogen after harvest was observed in organic farming (840.73 mg kg-1), followed by POP (832.79 mg kg-1) and natural farming (825.75 mg kg-1). The significantly lower value of total nitrogen was recorded in farmer's practice (795.62 mg kg-1). The increase in total nitrogen in organic farming maybe attributed to increase in level of organic carbon in organically treated soils. Total nitrogen followed the organic carbon level because the soil-internal cycling is linked to organic carbon. The increase in organic carbon and total nitrogen, has been observed in organically managed soils compared to conventionally managed soils receiving chemical fertilizers only (Regonald, 1988; Drinkwater et al. 1995). Kaur and singh (2014) also found the increase in total nitrogen, 23.1 percent more in FYM application than organic fertilizer alone (Table 7 and figure 7).

Available nitrogen (mg kg^{-1})

Among four treatments, the significantly higher value of available nitrogen at 30 DAS was observed in farmer's practice (140.65 mg kg^{-1}), followed by POP (138.81 mg kg-1) and organic farming (136.67 mg kg^{-1}). The significantly lower value of available nitrogen was recorded in natural farming (134.74 mg kg-1). At 60 DAS, the significantly higher value of available nitrogen was observed in POP (142.59 mg kg^{-1}), followed by farmer's practice (141.17 mg kg^{-1}), and organic farming (138.73mg kg^{-1}). The significantly lower value of available nitrogen was observed in natural farming (136.88 mg kg^{-1}). At 90 DAS, the significantly higher value of available nitrogen was observed in POP (158.84 mg $kg^{-1)}$, followed by farmer's practice (153.95 mg kg^{-1}), and organic farming (141.04 mg kg^{-1}). The significantly lower value of available nitrogen was observed in natural farming (138.07 mg kg-1). After harvest of the crop, the significantly higher value of available nitrogen was observed in POP (169.68 mg kg^{-1}), followed by farmer's practice (161.71 mg kg^{-1}), and organic farming (152.79 mg kg^{-1}). The significantly lower value of available nitrogen was observed in natural farming (139.84 mg kg^{-1}). The significantly higher value of available nitrogen was recorded in treatment receiving fertilizers and FYM, maybe due to lower C:N ratio of FYM, which hastens mineralization of nitrogen in soil. It is likely that the same factors that contributed to the rise in organic C also contributed to the rise in soil-available N in the soil that had organic manure added to it. Puranik et al. 1978, Kher and Minhas (1972) and Ayuso et al. (1996), are in agreement that continuous use of organic manure increases available nitrogen in soil (Table 8 and figure 8).

NH4+-N (mg kg-1)

At 30 DAS, the significantly higher value of NH4+-N was observed in farmer's practice (12.80 mg kg-1), followed by POP (11.62 mg kg-1), and organic farming (10.67 mg kg-1). The significantly lower value of NH4+-N was observed in natural farming (8.73 mg kg-1). At 60 DAS, the significantly higher value of NH4+-N was observed in farmer' practice (13.20 mg kg-1), followed by POP (12.79 mg kg-1), and organic farming (11.54 mg kg-1). Significantly lower value of NH4+-N was observed in natural farming (9.72 mg kg-1). At 90 DAS, the significantly higher value of NH4+-N was observed in POP (14.84 mg kg-1), followed by farmer's practice (13.86 mg kg-1), and organic farming (11.91 mg kg-1). Significantly lower value of NH4+-N was observed in natural farming (10.64 mg kg-1). After harvest of the crop, the significantly higher value of NH4+-N was observed in POP (16.68 mg kg-1), followed by farmer's practice (14.81 mg kg-1), and organic farming (12.76 mg kg-1). The significantly lower value of NH4+-N was observed in natural farming (11.26 mg kg-1). Because gypsum includes sulphur and encourages plants to grow roots more effectively, the buildup of NH4+-N was higher in POP, suggesting that more nitrogen was perhaps being fixed there. Yaduvanshi (2001) noted that the application of FYM and urea together reduced

ammonic volatilization losses. These results are supported by earlier works of Rajput et al. (1984), Thakur et al. (1992), Mikha and Rice (2004), Venugopal et al. (2017) and Kushwaha (2011) (Table 9 and figure 9).

NO3- -N (mg kg-1)

At 30 DAS, the significantly higher value of NO3- -N was observed in farmer's practice (9.82 mg kg-1), followed by POP (8.74 mg kg-1) and organic farming (7.54 mg kg-1). The significantly lower value of NO3- -N was recorded in natural farming (5.74 mg kg-1). At 60 DAS, the significantly higher value of NO3- -N was observed in POP (10.59 mg kg-1), followed by farmer's practice (10.10 mg kg-1) and organic farming (8.63 mg kg-1). The significantly lower value of NO3- -N was observed in natural farming (7.60 mg kg-1). At 90 DAS, the significantly higher value of NO3- -N was observed in POP (12.48 mg kg-1), followed by farmer's practice (11.34 mg kg-1) and organic farming (10.57 mg kg-1). The significantly lower value of NO3- -N was observed in natural farming (9.38 mg kg-1). After harvest of the crop, the significantly higher value of NO3- -N was observed in POP (14.35 mg kg-1), followed by farmer's practice (12.84 mg kg-1), and organic farming (11.62 mg kg-1). The significantly lower value of NO3- -N was observed in natural farming (9.64 mg kg-1). Udaysooriaan et al. (1989) investigated the impact of constant manuring and fertilisation on the soil nitrogen fractions during a seven-year period in an Alfisol intensive cropping system and found that the total, ammonia, nitrate and organic nitrogen contents significantly increased. All nitrogen components in the soil rose while using organic manures at a rate of FYM @ 25 t ha-1 per crop. Similar results were obtained by Verma and Bhagat (1994), Basumatary and Talukdar (1998) and Santry et al. (1998) (Table 10 and figure 10).

Correlation coefficient between nitrogen fractions and yield as influenced under different nutrient management approaches

Correlation coefficient between nitrogen fractions at 30 DAS and yield

Correlation studies reported that there was significantly positive, correlation between total nitrogen and pod yield (r=0.955*), haulm yield (r=0.973*), kernel yield (r=0.988*) and no. of pods per plant (r=0.997**) at 30 DAS. Available nitrogen was significantly and positively correlated with pod yield (r=0.958*), haulm yield(r=0.979*), kernel yield (r=0.989*) and no. of pods per plant (r=0.994**). Further, NH4+-N was also positively and significantly correlated with haulm yield (r=0.972*), kernel yield (r=0.962*) and no. of pods per plant (r=0.963*) at 30 DAS.

NO3- -N was also positively and significantly correlated with haulm yield (r=0.983*), kernel yield (r=0.976*) and no. of pods per plant (r=0.973*) at 30 DAS (Table 11).

Correlation coefficient between nitrogen fractions at 60 DAS and yield

Correlation studies showed that there was positive correlation between total nitrogen and pod yield, but significant correlation with haulm yield (r=0.967*), kernel yield (r=0.983*) and no. of pods per plant (r=0.996**) at 60 DAS. Available nitrogen had positive correlation with haulm yield, kernel yield and no. of pods per plant but, significant and positive correlation with pod yield (r=0.962*). NH4+-N showed positive correlation with no. of pods per plant, but had significant and positive correlation with pod yield (r=0.956*), kernel yield (r=0.990*) and haulm yield (r=0.966*). NO3- -N showed positive correlation with kernel yield, but had significant and positive correlation with pod yield (r=0.988*) haulm yield (r=0.998**), kernel yield (r=0.997**) and no. of pods per plant (r=0.982*) (Table 12).

Correlation coefficient between nitrogen fractions at 90 DAS and yield

Correlation studies showed that there was positive correlation between total nitrogen and no. of pods per plant, but positive and significant correlation between total nitrogen and pod yield (r=0.956*), haulm yield (r=0.990**) and kernel yield (r=0.969*) at 90 DAS. Available nitrogen showed positive and significant correlation with pod yield (r=0.982*), kernel yield (r=0.993**), haulm yield (r=0.968*) and no. of pods per plant (r=0.990**). NH4+-N showed positive and significant correlation with pod yield (r=0.980*), haulm yield (r=0.990**), kernel yield (r=0.998**) and no. of pods per plant (r=0.993**). NO3- -N showed positive correlation with pod yield, but significant positive correlation with haulm yield (r=0.962*), kernel yield (r=0.968*) and no. of pods per plant (r=0.981*) (Table 13)

Correlation coefficient between nitrogen fractions after harvest and yield

Correlation studies showed that there was positive correlation between total nitrogen and pod yield, haulm yield, kernel yield and no. of pods per plant after harvest. Available nitrogen had positive correlation with pod yield and significant positive correlation with haulm yield (r=0.983*), kernel yield (r=0.977*) and no. of pods per plant (r=0.975*). NH4+-N had positive and significant correlation with pod yield (r=0.953*), haulm yield (r=0.969*), kernel yield (r=0.987*) and no of pods per plant(r=0.998**). NO3- -N showed positive correlation with pod yield, but positive and significant correlation haulm yield (r=0.972*), kernel yield (r=0.971*) and no. of pods per plant (r=0.977*) (Table 14).

The correlation coefficient (r values) emerged out suggest that pod yield, haulm yield, kernel yield and

no. of pods per plant were predominantly dependent on total nitrogen, available nitrogen, NH4+-N and NO3- -N. The impact of long-term manuring and fertilization on forms of nitrogen was investigated by Prasad et al. in 1986. They noticed a substantial relationship between the available nitrogen, ammonia, and nitrate-nitrogen and the wheat yield. Dinev and Stancheva (1995) also noted that nitrate and ammonia together contributed most to maize biomass production, whereas greatest biomass accumulation with NO3-N was recorded for wheat. Similar results were previously reported by Prasad and Rokima (1991), Srivastava (1975) and Srivastava and Srivastava (1993).

IV. CONCLUSION

Initial soil properties like bulk density, pH, EC and OC did not change significantly among the treatments. However, the highest nutrients status i.e. nitrogen, phosphorus, potassium, calcium, magnesium and sulphur were recorded in POP practice. Among nitrogen fractions, total nitrogen was found significantly higher in organic farming system at all growth stages of groundnut. Moreover, the other fractions like available nitrogen, NH4+-N, NO3- -N were highest in POP practice, followed by farmer's practice. Correlation studies proved that nitrogen fractions like available nitrogen, NH4+-N and NO3- -N were positively correlated with yield.

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